https://doi.org/10.3926/hdbr.196

Technological change, opening and internationalization of Spanish telecommunications. The transition to the third generation of mobile telephony

Ángel Amado Calvo Calvo
Professor Emeritus in the College of Economics and Business at the University of Barcelona. Spain.
ORCID: 0000-0002-1370-9970.

angel.calvo@ub.edu

Received: December, 2017.
Accepted: December, 2018
Published: June, 2019.

Abstract
This article explores from a multidisciplinary and transnational historical approach the impact of technological change on the structure of the telephone sector, the fruit of advances in microelectronics and information technology. This problem has been studied in Spain basically by regulatory specialists, on the one hand, and technologists, on the other. We lack a more transversal analysis that puts into play the various elements that intervene. This article is intended to cover this gap, based on unpublished primary sources –primarily from Telefónica– as well as in other documents of diverse origin. Specifically, it focuses on the role played by Spain and the historic telephone company (Telefónica) in the transition to the third generation of mobile telephony (Universal Mobile Telecommunications System, UMTS) and gives prominence to the national state, to the supranational bodies –EU and International Telecommunication Union (ITU) and companies.

Keywords
Mobile telephony, Universal Mobile Telecommunications System, Telefónica, licenses, operator debt, internationalization.

How to cite this article
Calvo, Á. A. (2019). Technological change, opening and internationalization of Spanish telecommunications. The transition to the third generation of mobile telephony. *Harvard Deusto Business Research,* VIII(1), 3-30. https://doi.org/10.3926/hdbr.196

Mobile telephony is based on different systems or standards, each with its own protocol or language; it consists of access networks, a central network, system elements and network architecture.

1. Second generation mobile telephony around the world

Technological change in telephony and its repercussions on service, the product in essence of the advances made in microelectronics and computer technology, have received a great deal of attention in Spain, basically from specialists in regulatory issues, on the one hand, and technologists, on the other[1]. In our opinion, what is lacking is a more cross-disciplinary analysis that puts the different intervening elements into play. This article is intended to cover this deficiency, from a multidisciplinary and transnational historical focus, based on unpublished primary sources – first and foremost, from Telefónica and an exceptional file from the Ministry of Industry – as well as other documentation from various origins[2]. Specifically, it focuses on the role played by Spain and the country's historic telephone company (Telefónica) in the transition to the third generation (Universal Mobile Telecommunications System, UMTS) of mobile telephony, and the leading role of the national state, supranational organizations (the UE and the International Telecommunication Union, ITU) and companies.

It is commonly accepted that European leadership in the development and deployment of the second generation of mobile telephony, predominantly using a system called Global System for Mobile Communication (GSM), did not reoccur with the adoption of the subsequent systems. Indeed, the third generation in its Universal Mobile Telecommunications System (UMTS) variant had a slow beginning as compared to the fast adoption in the USA and Asia[3]. Moreover, if we consider the 2015 OpenSignal report, Europe did not lead the deployment of 4G, which was dominated by the Long Term Evolution (LTE) system, promising better, faster service and more extensive features[4]. There are discrepancies among the specialists when it comes to determining the causes for this situation.

Before continuing, we would like to explain a series of basic concepts that make it easier to follow the rationale. To begin with, the radio spectrum is a range of radio frequencies used publicly or privately to provide basic communications services – radio, radar and mobile telephone services. Its condition as a finite resource determines the institutional intervention in its assignment, along with its enormous and growing economic importance (National Audit Office, 2001, p. 1). Band width generally refers to the volume of information per unit of time that a means of transmission, for example, an Internet connection, can channel.

Mobile telephony is based on different systems or standards, each of which uses a certain protocol or language and consists of access networks, a central network, system elements

1 As representative examples, see Elias, Berenguer and Mataix (2016) and Calzada and Estruch (2011), pp. 39-69, respectively.

2 As professed by leading authors, the history of mobile telephony refers to both social and political developments and to the emergence of new technologies, standards and systems (Lacohée, Wakeford† and Pearson, 2003, pp. 203-211).

3 The ITU limits the official designation of IMT-Advanced to LTE-Advanced and WirelessMAN-Advanced, as the most advanced technologies for global wireless mobile broadband communications (4G), although it recognizes that this term may also apply to the precursors of these technologies: LTE, WiMax and other evolved 3G systems that provide a substantial level of improvement in terms of performance and capacities (ITU, **2010).**

4 The USA adopted different 3G systems; in parallel the FCC supported the standardization of both Qualcomm's IS-54 and D-AMPS (IS-95), product of the collaboration between ATT and Motorola (Bornheim, 2001, p. 19; Glimstedt, 2017, p. 20). In the USA, new mobile telephony customers dramatically increased in number, drawn by the drop in prices. In 2002, in more than half the homes in the country, someone was signed up for wireless telephone services, a percentage that more than doubled the figure from seven years earlier (*New York Times*, November 18, 2002). Some authors reject the pessimistic vision of the role played by Europe, stating that the price levels and the data rates provided indicate the success of 3G, as well as 4G on the other hand, from the perspective of consumer wellbeing (Lemstra, Cave and Bourreau, 2017, p. 11). Regarding the problems surrounding the 3G standards, see Walke, Seidenberg and Althoff (2003); for 4G, see Medudula, Sagar and Gandhi (2016), pp. 81-85. At the end of 2015, the global 4G connection base exceeded one billion users in 151 countries around the world (GSMA, 2016, p. 2).

While the first-generation mobile telephony networks offered simple analog voice capabilities, second-generation GSM added some data services, such as email and fax.

and a network architecture (ElNashar, El-saidny and Sherif, 2014)[5]. From the business perspective, mobile telephony is characterized by the high deployment costs of the infrastructures and by the relative lateness in achieving suitable profitability (Lescuyer, 2012, p. 7)[6]. Also noteworthy is its positive impact on economic growth, in such a way that a 10% increase in the mobile penetration rates increases the total productivity of the factors by 4.2% (Deloitte, GSMA and CISCO, 2012, p. 2).

In terms of the diversity of modes, mobile telephony, the third great wave in modern telecommunications, after the telegraph and conventional telephone, provided an unimaginable opportunity for expansion for an invention that was more than a century old, while also constituting a tool to change the world (Klemens, 2013)[7]. While first generation mobile telephony networks offered simple analog voice telephony, the second generation GSM added certain data services, such as email and fax (Jehiel and Moldovanu, 2001, p. 1).

The successor to the analog systems adopted on a continental or national scale (Goldsmith, 2005, p. 595)[8], GSM traces its roots back to 1982, when the European Conference of Post and Telecommunications (CEPT, according to its initials in French) created a work group charged with developing standards for a pan-European digital mobile network. Fifteen signers from thirteen European countries (immediately followed by another five) agreed to renounce their various analog systems and launch the project that would become the Pan-European Digital Mobile Service (GSM), a multilateral convention establishing deadlines and identical conditions. The new European digital system was, in all reality, a network standard, and not just a product standard, and it therefore provided potential benefits derived from the related network externalities. It guaranteed efficient management of scarce resources, good vocal quality and advanced features for security and data. Based on WAP (Wireless Application Protocol), it permitted what was still precarious access to the Internet with low data transmission speeds and required rates to be based on connection time. The agreement had important implications for the industry in the participating countries, so the battle to defend the

5 UMTS consists of four logical blocks responsible for totally different things. The UMTS Subscriber Identity Module (USIM) is a chip card with specific information about the user and an authentication key for network access. The UMTS terminal or mobile multimedia equipment delivers the stack of protocols from the radio interface, as well as the operational elements of the user interface. The fixed network infrastructure or Radio Access Network (RAN) contains the installations required for radio transmission. As a long-range network, the Core Network (CN) transmits a user's data to its respective destination, thanks to numerous switching systems, gateways to other networks, such as the Integrated Services Digital Network (ISDN) or the Internet, and databases and installations for network management (Walke *et al.*, 2003, p. 47). IGI Global defines **a protocol** as "a special set of rules that end points in a telecommunication connection use when they communicate."

6 In 1995, the telecommunications service market was estimated to be worth 143 billion ecus, of which 12% was generated in the area of mobile services. A very large increase was expected in the near future, which would increase this percentage to 25% of the total income for the year 2000 (Girard and Gruber, 1996, pp. 1-2).

7 Expressed colloquially, "mobile telephony has launched revolutions, saved lives, destroyed relationships and, of course, spawned a whole new genre of utterly pointless" (*The Guardian*, May 6, 1986).

8 The first manual mobile telephony systems were developed in the USA in 1946; the Swedish MT A was the first automatic commercial system (1956). 2G standards: Advanced Mobile Phone Service (AMPS) developed by Bell Laboratories in the 1970s, marketed in the United States in 1983 and later expanded; the Japanese MCS-L1 from NTT, based on AMPS, but at a higher frequency and including voice; the European Total Access Communication System (TACS), which operated at a higher frequency and with channels that had a narrower bandwidth than AMPS; with a more restricted geographical scope (roaming) was the pan-Nordic system Nordic Mobile Telephone (NMT), the first of its kind in the world, and developed in a cooperative effort among the Scandinavian countries, which made great efforts towards negotiation and finding consensus among the creators and those affected by the new technologies (Mercer, 2006, p. 113; Goldsmith, 2005, ▫p. 595; Papadimitriou et al., 2003, p. 121; Craninckx and Steyaert, 1998, p. 3). NMT owed its success to "improved user comfort, miniaturized components and acceptable cost of the terminals" (Ketterling, 2004, p. 3).

Telefónica undertook to participate in all four phases set out for the introduction of the GSM system (review of specifications, acquisition, component development, system testing and implementation, and service expansion).

various interests became especially harsh (Conversation with Luis Lada, June 17, 2013; Natvig, 2004, p. 182; Selian, 2001)[9].

The second generation GSM system reached noticeable levels of expansion and spread on a global scale. This success can only be explained by the cooperation, flexibility and adaptability on a national level, the latter being one of the key factors of differentiation between the diffusion of the second and third generation technologies (Eskelinen, Vatne, Maskell, Malmberg and Hannibalsson, 2002, p. 163)[10]. By mid-1997, the new system had deployed 200 networks in more than a hundred countries, with a total of 44 million subscribers. Only four years later, this standard was chosen by 70% of mobile telephony subscribers (Lescuyer, 2012, p. 1). Five years later, under the effects of the economic crisis, the overwhelming predominance of the GSM standard around the world was maintained, with 69% of subscribers, distantly followed by three other second generation systems: CDMA, with 13%; TDMA, with 10%; and PDC, with 3% (ITU, 2002)[11].

2. Second generation mobile telephony in Spain

Spain, a country whose mobile telephony history dates back to the early 1970s, joined the GSM agreement as a member outside the hard-core of France, Germany, United Kingdom and Italy, and the Nordic core formed by the Scandinavian countries, with no option in the latter case to optimize its potential advantages[12].

Officially backed by government delegation, the historic telephone operator Telefónica undertook participation in all four phases anticipated to introduce the GSM system. Altogether, they included the revision of specifications; acquisition activities; the development of the system components, testing and implementation; and finally, the expansion of the service[13]. According to the obligations entered into by the signing parties to focus on specific areas, it was undertaken to establish a commercial service in the Spanish capital and two experimental systems were acquired to test them in two other great events that took place in 1992: the Barcelona Olympics and the Seville World Expo[14].

9 In 1982, the CEPT decided to reserve the frequency bands in the area of 900 MHz for mobile cellular systems (Lembke, 2002, p. 139). The GSM participants were formed by the four-party group (Germany, France, Italy and the United Kingdom), the Nordic group (Denmark, Finland, Norway and Sweden) and the rest of the CEPT group (Bliksrud, 2004, p. 198). The initials GSM, originally taken from the less-than-commercial name 'Groupe Spécial Mobile', created by the Telecommunication Commission under the framework of the Harmonization Committee, were maintained, but their meaning was changed to the Global System for Mobile Communication. It is worth remembering the official impetus: the French government made a firm commitment to GSM, in the hopes that a pan-European system would offer scale economies to industries and national service providers (U. S. International Trade Commission, 1993, p. 4/7).

10 It was the "right system, at the right place and the right time" (Selian, 2001), promising 'easy ubiquity' (Kelen, 2001, p. 188). The European Commission pointed out the affordable service provided to a wide market segment, the decrease in the cost of analog mobile telephony and the offer of a range of complementary services (European Commission, 1997, p. 103). The success of GSM owes to a double movement of initial interstate negotiation and the subsequent collaborative implementation following the agreement (Selian, 2001, pp. 5-6).

11 Code Division Multiple Access (CDMA); Time Division Multiple Access (TDMA) and Personal Digital Cellular (PDC). As mechanisms to prevent interferences and collisions between users, CDMA is a scheme that permits different users to simultaneously share the available capacity of a common channel, while in the TDMA scheme, users transmit at different times, and thus the data bits are interspersed in the same means of communication (Muhammad, 2008, p. 1; Umar, 2004, p. 5/45).

12 Practically all the specialists cite the mobile communications for ships (1970) and automobiles (TAV) (1976) (Elias *et al.*, 2016, p. 85). Spain could not benefit from scale economies in the production of mobile terminals because NMT operated in Spain at frequencies that were slightly higher than those of the Nordic countries (Gruber, 2005, p. 91).

13 *LACA*, February 24, 1988.

14 After the start of the new millennium, Forum Barcelona 2004 incorporated the UMTS system into the project at the initiative of Telefónica Movistar, in spite of the lack of suitable telephone terminals.

In 1992, the five large European telephone operators agreed to develop a pilot broad band European network based on the ATM (Asynchronous Transfer Mode) system.

The promotion of the information superhighway in Europe provided the operator with a new opportunity to position itself. Different international agreements made it possible to consolidate the basic elements of the new generation, particularly interoperability. In the aftermath of this frenetic year 1992 referred to above, full of international events, an agreement was reached with the four European operators (BT, FT, the Italian STET-ASST and the German Deutsch Bundespost Telekom, which a few years later would change its name to Deutsche Telekom A. G. and become privatized)[15]. Open to others, the agreement sought to develop the pilot European broadband network according to the ATM system (Asynchronous Transfer Mode). This culminated the efforts of the European Institute for Research and Strategic Studies in Telecommunications (EURESCOM) to ensure the interoperability of the networks and the dissemination of R&D in the European Union as basic elements for the creation of advanced European networks. Making the project possible required each operator to acquire and install ATM equipment on its respective networks, interconnecting them with 34 Mbit/s links (Turner, 1997, p. 51).[16]

From the Spanish market side, the Telefónica administration was very careful to stress that the ATM networks contributed the capacity for multiplexing, switching and transporting information in any telecommunications service, from high-speed data transmission to video communication[17]. By joining the European Multimedia Experiments in an ATM Environment (EMMA) project, a commitment also made by EURESCOM to promote international interoperability, Telefónica had access to the infrastructure of the European ATM pilot network for experimentation in multimedia services. The purpose concerned the development of technical solutions for potential services and applications that would be supported by the future commercial ATM network[18].

Two years after the boom of 1992, two important events occurred. Telefónica joined as a founding partner in the ACE 2000 Forum, on the same level as BT, Deutsche Bundespost Telekom, FT and STET. The aim was to exchange ideas and promote pilot experiences to provide new services to users. The recently created entity expected to set aside 80 billion pesetas (500 million ECUs) in its first year for research and development in broadband technology. Another 16 billion were reserved for building the pilot European network based on ATM as the first step towards the information superhighway in Europe. Next, seventeen European operators inaugurated the pilot phase of this superhighway, aspiring to become the base for the future broadband RDSI, suitable for all types of telecommunications services, but still lagging behind the revolutionary Internet in terms of amplitude for its twenty million users at the time[19].

15 The name change occurred in 1995 and the company was privatized the following year (Lemstra and Melody, 2014, p. 171).

16 Started in 1991 as an important investment by European operators in public networks, the **pan-European ATM** Pilot program was formalized by a memorandum of understanding (MOU) signed on November 12, 1992 by five European operators (BT, Deutsche Telekom, France Telecom, Telecom Italia and Telefónica), which were soon joined by another eleven (Belgacom, PTT Telecom Nederland, Swiss Telecom PTT, Telecom Finland, ATC Finland, the Swedish company Telia AB, the Norwegian Telenor AS, Portugal Telecom, Telecom Danmark, Telecom Eireann and Austrian PTT) (Rao, Uose and Luetchford, 1996, pp. 35-42); the MOU established the broadband telecommunications services based on ATM technology, focusing on the network interface and network management functions as a support for interoperable European services (Christensen-Dalsgaard, Donnelly and Griffith, 1999, p. 228).

17 *LACA*, November 25, 1992. Participation in ten EURESCOM projects, worth 24 million pesetas in 1991 *(ACE*, October 30, 1991).

18 *ACE*, June 29, 1994; Eurescom, P460SI EMMA - European Multimedia Experiments in an ATM Environment. The information superhighways were conceived as physical means or national infrastructures joined together to build a network of networks called the global information infrastructure (Linares and Ortiz, 1995).

19 *ACE*, June 15, 1994. It consisted of a pilot optical fiber network of more than 10,000 kilometers to provide computer-based voice, data and image services, without neglecting access to new interactive on-demand television, online education and telecommuting services. Spanish ATM network coverage was initially limited to the metropolitan areas of Madrid and Barcelona (*El País*, November 25, 1994). ATM was the transport technique to ensure effective voice, video and data support on the same network, with noticeable cost reductions and faster speed; it used small data packets with a fixed length of 53 bytes (Korhonen, 2003, p. 235; Lundmark and Oster, 1998, pp. 3-9).

The government awarded three GSM licenses to Telefónica, Amena and Airtel and two individual B2-type licenses to Telecommunications par Satellites Mobiles and Iridium Communications Germany to provide voice telephony services.

Shortly after 1994, the ATM network in Spain covered the metropolitan areas of Madrid and Barcelona and provided transit services from Portugal to the rest of Europe, although its list of subscribers was still rather sparse. In essence, it was limited to the subsidiary Telefónica R&D and the Higher Technical School of Telecommunications Engineers at Madrid Polytechnic University[20].

Around these dates, in the draft of its telecommunications policy during the transitory phase to full competition, the Spanish government, in the hands of the Spanish Socialist Party (PSOE), advocated improving business competitiveness, ensuring universal access to basic telecommunications services and promoting the development of a national telecommunications sector. According to the final calendar for implementing GSM, during the second half of 1994 the technical regulations and rates were approved, and the date was set for the tender awarding the second license. In an effort to liberalize telecommunications, the government awarded three GSM licenses to three additional operators: Telefónica, Amena and Airtel. Two individual B2-type licenses were granted to Telecommunications par Satellites Mobiles, S.A.S. and Iridium Communications Germany, GmbH for the provision of voice telephony services available to the public through the establishing or operation of a public mobile telecommunications network that was either land- or satellite-based. Seven individual C2-type licenses were granted to seven operators: RONDA Grupo Consultor, S. L.; Hot Telecommunications, Ltd; Telespazio, S.p.a.; Eter Comunicaciones, S. L.; Tarifa Plana, S. L.; Globalcom Insa, S. A.; and Telefónica Servicios Audiovisuales, S. A.[21] Telefónica was an indisputable contender for a license to provide services for the mere transformation of its current authorization or license, based on its government contract. After half a year of proceedings and the deposit of a 4-billion pesetas bank guarantee, in February 1995 it managed to transform its license and immediately afterward the GSM service concession contract was signed. Finally, Telefónica requested to transfer said administrative concession to its subsidiary Servicios Móviles, S. A. (Calvo, 2016, pp. 194-195).

As the late Enrique Used indicated, Telefónica Móviles adopted a selective expansion policy with regard to mobile telephony in Spain. In other words, more than the economic or social elites, it targeted a potential clientele made up by groups of workers who performed their jobs on the street. The second pillar of the approach to expansion focused on reducing the costs for the mobile connection fees. This goal was not achieved, and this had detrimental effects on the service[22]. Instead of responding to the social need, the deployment of GSM ran into numerous administrative obstacles and resistance from users, who were wary of the effects that this multiplication of infrastructures would have on health and the environment (Navío, J., 2004: Interview with Cayetano Lluch. *Bit*, 147, October-November 2004, 24-29)[23]. However,

20 The European network based on ATM technology was inaugurated on October 24, with a video conference between Dublin and Brussels (*LACA*, November 30, 1994). By joining the Ten-34 project under the auspices of the EU, Telefónica committed to developing broadband telecommunications and the interconnection of national scientific networks, among them the Spanish Iris network (*ACE*, April 24, 1996).

21 Retevisión Móvil began offering its services on January 24, 1999 in ten cities under the commercial name Amena. With this, at the end of 1998, in Spain all telecommunications services were provided within a competitive system; the USA opted to use the 1900 MHz band (Elias et al., 2016, pp. 141-142). The holders of individual C2-type licenses could establish or operate their own network using the public domain portion of the radio spectrum, excluding the provision of voice telephone services to the public by means of a land- or satellite-based network (Muñoz, 2000).

22 Telefónica opted for UMTS without any guarantees regarding its availability in a specific period of time, but with the certainty that in a few years the mobile telephone would become a universal personal communicator and that renouncing UMTS would mean a collapse of the networks (Luis Lada in Zafra, 2000). Used indicated that in Italy, mobile telephones made of wood were sold that people used to simulate conversations, demonstrating the existence of an unmet need in society *(BOLSA*, March 2007, p. 53).

23 3G would require 30% more stations than GSM. As Javier Nadal confessed to the author of this work, Telefónica employed specialists to explain in detail to subscribers the lack of danger posed by the mobile telephony antennas.

More than to economic or social elites, mobile telephony in Spain was oriented towards a potential clientele consisting of groups of workers who performed their work in the street.

the GSM system maintained its hegemony in Spanish mobile telephony until 2008, an aspect that will be addressed later (Graph 1).

3. Implementation of the Universal Mobile Telecommunications System (UMTS)

The arrival of the third generation of mobile telephony (3G) was preceded by the development of a bridge standard under the name of 2.5G and based on the GPRS (General Packet Radio Service) system, which improved the Internet connection, increased the transmission speed and made it possible to establish its cost based on the volume of data transmitted, as opposed to the connection time[24]. The growth in the demand placed on the mobile telephony system required the expansion of the band of frequencies used in Europe, with the addition of the 1800 MHz band to provide for the new DCS (Digital Cellular System)[25] mobile telephony service.

In the beginning, the third generation of mobile telephony, more than an immediate alternative to 2G, aspired to be a tool to optimize the existing operator networks and a complement to GSM, which offered new services (mainly multimedia) that had previously not existed (Papadimitriou, Pomportsis, Nicopolitidis and Obaidat, 2003, p. 121). 3G technology combined two innovations with long-ranging effects: wireless communications and the Internet.

We will now examine this topic in greater detail. In 1985**,** an international consortium under the auspices of the International Telecommunication Union (ITU) began work on the third generation systems under the acronym FSPTMT (Future Public Land Mobile Telephone System), a predecessor of the IMT-2000, and with the simple pretension of creating a pocket-sized mobile telephone capable of being used anywhere around the world (ITU, 1995, p. 1; Rappaport, Muhamed, Buehrer and Doradla, 2000, p. 8; Agar, 2013; Springer and Weigel, 2013, p. 91)[26].

Faced with the new generation of mobile telephony, the European Commission advocated harmonization and rationalization of the radio spectrum and a policy for the entire European Union, in accordance with the desire to promote a single telecommunications market and in pursuit of scale economies. Here lies one of the big differences between European mobile telephony and that of the United States, where the decision was left in the

[24] The 2.5G provided for new services, such as multimedia MMS messaging, a protocol for 3GPRS, with the capacity to send texts, images and audio (Telefónica R&D, 2003, p. 24). Most importantly, the 2.5G defined some of the 3G services and applications, and thus operators were reluctant to opt for 3G, whose main challenge laid in persuading 2G and 2.5G customers that the upgrade was worth it (OECD, 2004, p. 48).

[25] DCS-1800 MHz was known as GSM-1800, based on GSM technology, but operating in the 1800-MHz band frequency with greater capacity (Anttalainen, 2003, p. 204).

[26] FPLMTS were 3G systems conceived to unify the different systems that were then in existence in a radio infrastructure capable of offering a wide range of quality services (Callendar, 1994). According to the ITU, public mobile telephony systems are defined as land-based mobile systems for public correspondence based on radio stations connected to the public switched telephone network. In them, a series of general operating aspects applied: automatic configuration and charging of calls to and from the mobile station; for international systems, the capacity to establish calls between mobile stations and any landline or mobile subscriber, in the latter case, within the system; charging of the costs in a way that is compatible with the pricing principles of the public switched telephone network (PSTN); not requiring any significant changes in the landline telephony networks with the introduction of the system; maintaining the blocking probability within similar limits to those of the PSTN services in all stages of development and continuous quality control of the call, with automatic transfer between base stations as necessary. For a more precise definition, the U.S. landline mobile telephony system was designed to permit an automatic exchange of traffic with the public switched telephone network (PSTN) and offered a service to subscribers that was similar to that of landline calls: high voice quality, high degree of reliability, low blocking and a relatively low cost (ITU, 1978-1995, p. 1).

More than serving as an alternative to 2G mobile telephony, 3G aspired to be a tool to optimize the existing networks and a complement to GSM, which offered new (mainly multimedia) services.

hands of the market, causing the country to lag behind, technologically speaking (Columbus, 2004, p. 2). However, it is sometimes forgotten that it was also protected against financial squandering.

The operating companies were after an explosion of consumption in response to the size of the investments made, the good growth perspectives in these main markets and the big opportunities for increasing the declining income per subscriber[27]. But the El Dorado promised by UMTS would not come to fruition because the technology was not yet ready (users had the networks, but not the terminals), and the deployment of other technologies was potentially much cheaper, such as the aforementioned GPRS (General Packet Radio Services), Enhanced Data for Global Evolution (EDGE) and WLAN (Wireless Local Area Network)[28].

UMTS was presented with enormous market potential, consisting of 65-71 licenses valued by the Schroder Salomon Smith Barney commercial bank at €158 billion. To the amount required to obtain the UMTS concessions, it was necessary to add as much as €175 billion over ten years for the construction of networks, without forgetting the increasing amounts for investments in contents[29]. The total income generated by UMTS was estimated to be 300% higher than that of the existing GSM networks (Little, 2001, p. 11).

Slightly before the end of the 20th century, the European Commission arranged with telecommunications operators and manufacturers to speed up the introduction of 3G without setting any common standards[30]. Two opposing groups were formed. On the one hand were the Scandinavian countries and Spain, defenders of quick development, who established a very low price (and even absolute gratuitousness) for licenses. On the other hand were those bedazzled by the brilliant results of the license auction in the United Kingdom, in the midst of

27 *L'Expansion*, September 14, 2000.

28 *The Wall Street Journal*, June 18, 2000. After 2001, data flowed in packets following the adaptation of the existing network, which made it possible to connect to the Internet. Cingular **Wireless,** the first operator in the world to launch EDGE at 850 and 1900 MHz, chose it because of its performance or capacity and spectral efficiency (traffic capacity and service quality) that were competitive with any other technology option (Halonen, Romero and Melero, 2004, p. xxi and 173). While some analysts saw WLAN and 3G (both wireless technologies that improve different degrees of mobility and that allow users to use services) as complementary, other interpret WLAN as a potential threat to 3G. The delay in marketing 3G led to the strengthening of the 2G and 2.5G services. The lack of commercial availability of the 3G networks obligated Bouygues Télécom, for example, to resort to EDGE technology for multimedia mobile services in late 2003 (OECD, 2004, pp. 48-49).

29 The Bank of France estimated the total cost of UMTS license acquisition in Europe to be $136 billion (more than 980 billion francs), not counting the costs related to network construction; it called for caution and advised about the risk of default by operators. Bouygues Télécom, one of the three GSM operators in France and contender for the license, resorted to a €6 billion loan (nearly 40 billion francs), more than half of which was dedicated to its UMTS strategy (*Le Nouvel Observateur, December 21, 2000)*. The spectrum reassignments for mobile services between 1994 and 2000 represented increases of 250% in investment and 300% in job positions (Telecommunication Industry Association, 2011, p. 1). The cost of UMTS in Europe reached €352.362 billion in 2002, more than half of the entire Spanish GDP forecasted for 2003. The initials UMTS have facetiously been said to stand for 'Unlimited Money To Spend' (*El País*, September 29, 2002).

30 In all reality, there was a "financial, regulatory and political holy war for control of the wireless future" that shattered the project by the International Telecommunication Union, the responsibility for which was attributed in part to the intransigence of Ericsson and Qualcom, who were staunch defenders of their respective WCDMA and CDMA systems. In pursuit of their goal to lead CDMA and the wireless Internet markets through strategic investments in newly founded companies, Qualcomm pressured the government and launched strong investments ($500 million) in its venture capital division Qualcomm Ventures (*New York Times*, February 15, 1999 and November 15, 2000; *Cnet*, January 2, 2002). Different entities in the North American administration lashed out against establishing a single standard in Europe, in open contradiction to the WTO obligations and the ITU guidelines, considering it prejudicial for the U.S. industry. The European Commission assured its transatlantic ally that Europe would respect the competition and would be open to alternative systems (Mock, 2005, p. 206; Press Statement by James P. Rubin, Spokesman, December 22, 1998; European Commission, Press Release, Brussels, January 18, 1999; *EE Times*, 1/21/1999).

UMTS telephony was introduced with enormous market potential, and consisted of 65-71 licenses. It was estimated to generate 300% more revenue than the existing GSM networks.

the financial telecommunications bubble[31]. The 3G spectrum auctions held back then in Europe collected between 150 and 600 dollars per capita (Fuentelsaz, Maícas and Polo, 2008, pp. 436-449; The Council of Economic Advisers, 2000, p. 1).

The first four UMTS mobile telephony licenses were granted free of charge in Finland in 1999 to three operators and the Finnish consortium Suomen Kolmegee. The country bureaucratically established the number and size of the licenses in terms of the available radio spectrum, commonly known to be a scarce resource, and the companies. Germany, Greece and Austria used the tender to determine the number and size of the licenses, as well as the license holders. The United Kingdom and the Netherlands chose an intermediate procedure, according to which the number and size of the licenses was determined using bureaucratic methods, but the licenses were assigned to the companies through an auction (Appendix 1) (Cartelier, 2003, pp. 63-85; Khosrowpour, 2004, p. 132; Börgers and Dustman, 2002, p. 1; Börgers and Dustmann, 2003, pp. 215-268)[32].

Without detracting in the least from the chosen method, it would behoove us to keep in mind the procedure that was followed to implement each of the options. As an example, in Austria the regulatory agency carried out a public consultation on matters related to the introduction and awarding of UMTS licenses. In a second case, the interested parties took part in the configuration of the 3G license auction in Switzerland, using a dual track approach. They could express their opinions on different matters related to the concession through a public consultation and a discussion of the drafts of the bidding documents, the results of which were taken into account for the final version of the tender documents (*TRT*, June 15, 1999; OFCOM, **2000**)[33].

In terms of the concessions, in the United Kingdom, the first auction for UMTS licenses amounted to 22.5 billion pounds (€37 billion), which greatly exceeded the predictions (National Audit Office, 2001, p. 1). The Radiocommunications Agency proposed one of the two auction designs based on the Anglo-Dutch concept of Klemperer. They are hybrids consisting of a first part with ascending offers ("English") and a second part with sealed top-down offers ("Dutch")[34].

31 Registered and approved as bidders in the tender were ten consortia, including those already installed, i.e. Com Mobile (subsidiary of Swisscom), Orange (France Télécom 85%) and diAx (via dSpeed); other applicants were Cablecom Management (NTL), Sunrise Communications, Hutchison 3G Europe Investments, Team 3G (One.Tel of Australia, Sonera 3G and Telefónica), Telenor Mobile, T-Mobile and Teldotcom. The latter later abandoned the project, as did Cablecom Management, T-Mobile, Telenor Mobile, Hutchison 3G Europe Investments and the two partners of Telefónica in the Team 3G consortium (Curwen, 2002, p. 85).

32 According to the last two references, the tender strategies approved by the companies were much more complex than the economic theory predictions. The early options favored profits, while the later ones showed preference to efficiency (Janssen, 2004, p. 25). The theoretical contributions unaffected by the weight of the industry specificities regarding the UMTS license results (Klemperer, 2001; Klemperer, 1999, pp. 227-286) have been strongly questioned by other theorists, among them Kruse (2004, pp. 185-212), who advocated also considering factors such as the time and country. Some authors doubt about the rationality of the investments in UMTS, which could respond more to emotional reasons than sensible ones (Lurin, 2010, p. 296); an improved scheme for granting licenses that demonstrates the advantages of the traditional mechanisms due to their transparency for all candidates, their adoption of both comparative and financial criteria and their extreme flexibility so that the regulatory authorities can reach their objectives, be it increased revenue for the government or faster network deployment, the introduction of high competitiveness incentives or the reduction of the possibility of collusion and credit risk assumed by the governments (Louta, Roussaki and Anagnostou, 2003, pp. 113-120).

33 The 1999 public consultation in Switzerland showed that there was a sharp interest in the new licenses. Far from the countries of the economic center, Turkey created a National UMTS Coordination Board, on which were representatives of operators, companies and public organizations to participate in the granting of UMTS licenses (OCDE, 2002a, p. 150).

34 In the first part, the price of a license increases until five bidders are left; in the second phase, these five remaining bidders only present a final offer, with a minimum equivalent to the last valid price from the first phase. The licenses are then granted to the four highest bidders. The difference in the two formats lies in the price that the successful bidders pay. In the Anglo-Dutch discriminatory type of auction, the four winners pay for their respective offers (Abbink, 2001, p. 1). The Dutch top-down auction was rooted in the system used to sell tulips.

The first four UMTS licenses were granted free of charge in Finland in 1999. This country bureaucratically established the number and size of the licenses in terms of the available radio spectrum and the companies.

In the United Kingdom, the five licenses went to existing operators (Vodafone, Airtouch, BT Cellnet, New Orange and One2One) and to the Canadian operator TIW, supported by the Hong Kong Hutchison Whampoa group (Gruber, 2005, p. 260; *L'Expansion*, 636-642, February 1, 2001, p. 13; *L'Économiste*, May 6, 2000; *RedesTelecom*, October 22, 2007)[35].

Especially significant was the 3G auction in Germany, a country in which the increased demand for mobile telephony and Internet and the sharp decrease in prices in all telecommunications services promoted the real and potential growth of telecommunications. By mid-2000, the number of mobile telephony users reached the 34 million mark, and expected to climb to 48 million by year end[36]. The 3G license auction in Germany produced $46 billion, five times more than was expected by the government, while the per capita cost of the licenses remained €35 lower than the corresponding figures in the UK[37].

The European Commission had in its possession reports stressing the risks of implementing UMTS and their consequences for businesses. According to their conclusions, the first cause of the disaster lays in the unbridled expectations placed on the evolution of the market when the concessions began to be awarded, which pushed the prices higher. The second cause was found in the haste with which the operating companies acted, insisting on undertaking the sale of licenses without waiting for the arrival of suitable technology (McKinsey, 2002)[38].

Different analysts indicated that the crisis caused by UMTS would result in an unprecedented concentration of telecommunications on the European scene; only one peloton of five groups, led by the four 'giants' (Vodafone, France Telecom, Deutsche Telekom and BT), and in which Telefónica could enter, were among the winners[39]. Indeed, the high bids shook up the industrial structure in Europe, fueling the large companies with growing importance in Europe.

The colossal size of the market we are referring to obligated operators to engage in co-opetition, i.e., to form strategic alliances to obtain significant shares. The concession process produced noticeable variation in the scale and geographic distribution. Thirteen operators held nearly three-fourths of the second- and third-generation licenses proposed up to 2002 in all of

35 In an attempt to rationalize the behavior of the observed offer, highlight is put on the resistance of the data to provide specific evidence of certain rationalizations and the plausibility that without being confirmed or rejected directly by the data, rationalizes some of the offers made. The first five bidders to withdraw from the auction in the United Kingdom did so in quick succession; the withdrawals began in round 94 and ended in round 101, which closed phase 1 of the auction. The winners of the licenses and their offers were: A, TIW for £4.3847 billion; B, Vodafone for £5.964 billion; C, BT3G for £4.0301 billion; D, One2One for £4.0036 billion; and E, Orange for £4.095 billion (Börgers and Dustman, 2002, pp. 6-7).

36 With the deregulation of the telecommunications market in early 1998, the price of long-distance domestic calls fell by 89% and Internet use by 35%; Internet traffic doubled in 1999, a year in which the number of private customers increased by 70% (*The Wall Street Journal*, July 25, 2000).

37 The figures vary according to the source; in one, the Spanish figure was €15/h., with €648 in the UK, €171 in Holland, €613 in Germany, €240 in Italy, €82 in Austria and €337 in France (Van Damme, 2000, pp. 4-8). The high price of the German and British auctions was due to the fact that they took place early in the European auction cycle, when the major players believed that they needed to win in both key countries or lose the opportunity to develop a pan-European network. The debt loads of the successful bidders shot up at the same rate as the auctions (Cowhey, Aronson and Richards, 2008, p. 20). Debitel, associated with Swisscom, withdrew from the auction as a bidder, seduced by a favorable offer from Mobilcom (France Télécom) (Heuvelhof, De Jong, Kars and Stout, 2009, p. 127).

38 One of the worst scenarios possible came to pass: the income and profits from the new network were lower than expected and the company was confronted with problems with the debts they assumed to pay for the licensing rights (Ermoliev and Marti, 2012, p. 150).

39 *L'Expansion*, 636-642, February 1, 2001, p. 13; the Forrester Research agency predicted a drop of 15% in income per user in 2005 and the disappearance of profits by 2007, which would take six years to recuperate (*InfoWorld*, January 22, 2001, p. 52); Arthur D. Little (Little, 2001, p. 37) indicated that the financial pressures from the UMTS license rights and the network deployment costs, also indicated by Halonen et al. (2004, p. 468), were cause to predict greater consolidation in Western Europe.

In the United Kingdom, the five planned licenses went to the existing operators (Vodafone, Airtouch, BT Cellnet, New Orange and One2One) and the Canadian company TIW, with the backing of the Hong Kong group Hutchison Whampoa.

Europe (Whalley and Curwen, 2003, pp. 45-57)[40]. The intense growth of mobile telephony resulted in their being more than 600 million subscribers at the start of 2001.

4. Spain: between the domestic market and globalization

Spain spoke up once the European guidelines were already established. The Order of November 10, 1999 approved the schedule of administrative clauses and technical specifications for the tender of four licenses that governed the establishing of the telecommunications network and the provision of third generation service[41]. The government, then in the hands of the right, intended to attain two fundamental objectives of a more global, but less specific nature than the previous ones: quick access to the information society and overcoming the comparative backwardness of the country in developing it[42].

The government justified the selection of the tender method as a system for awarding the 3G mobile telephony licenses for several reasons[43]. First of all, it understood it as the traditional system systematically used in the Spanish legal system to accredit those entitled to provide public and telecommunications services. The other reason owes to the priority objective of situating Spain at the top in terms of developing this technology in Europe in its facets of greater and better implementation as a means to foster the information society. Furthermore, the government wanted to ensure a volume, pace and quality of the investment made in telecommunications infrastructures, affordable prices for all citizens and fast development of UMTS services. Fourthly, the government wanted to better meet the communication needs of citizens through greater concurrence in a sector characterized by the vitality of demand and high rates of current and future growth, without neglecting the provision of many other additional services that had so far been inviable, primarily access to broadband Internet. The promotion of investment and the creation of new jobs that achieving this purpose would bring along with it would inevitably have the effect of invigorating the Spanish economy[44].

The acting PP government, while the Congress was shut down, awarded licenses to three existing operators (Telefónica, Airtel and Retevisión-Amena) and one to the Xfera consortium. That was far from the examples of Austria and Switzerland described above, characterized by transparency[45]. In spite of the controversy generated, the Administration refused to nullify the

40 Telefónica's international strategy differs from that of BT and Deutsche Telekom in terms of their entry level (Cairo, 2014, p. 154).

41 *BOE*, 270, November 11, 1999, pp. 39.340-39.348. Jazztel characterized the bidding documents as a "mess," drafted "in a hurry and on the fly" (*Mercadofinanciero*, February 16, 2000).

42 *Diario de sesiones del Congreso de los diputados (DdSCD)*, Plenary session and Permanent delegation, 25, 9/20/2000, p. 1.101.

43 It is difficult to understand the Spanish government being included alongside the British and Italian governments as those capable of attracting great value through the concession of 3G licenses without any or very limited participation in their holders (Louta et al., 2003, pp. 113-120).

44 The minister of the area in question summarized the government's objectives as greater freedom, greater competition, better services and lower prices; in short, more and better employment *(DdSCD*, Plenary session and Permanent delegation, 25, 9/20/2000, p. 1.125).

45 From highest to lowest score, the successful bidders were Telefónica Servicios Móviles, S. A., Airtel Móvil, S. A., Retevisión Móvil, S. A. and Xfera Móviles, S. A. (*BOE*, 62, March 13, 2000, p. 10.327). The Xfera consortium was made up by Vivendi-FCC as the majority shareholder (27.5%), ACS (20%), Mercapital (17.6%), Sonera (15%), Acesa (7.9%), Orange (7%, belonging to Mannesman) and Ahorro Corporación (5%). The remaining consortia were Movi2 (Uni2, France Télécom and Iberdrola) and Movilwed 21 (Jazztel and Deutsche Telecom) *(ComputerWorld*, March 17, 2000). Movi 2 was a union formed by three companies from the sector (Lince Telecomunicaciones, S. A., Multitel Cable, S. A. and Suala Telecom, S. A.), three banking institutions (Caja de Ahorros and Monte de Piedad de Madrid and Cajas de Ahorros de Galicia y de Valencia, Castellón y Alicante) and a power company (Iberdrola Diversificación, S. A.). A public tender convened to grant four individual B2-type licenses to establish the required telecommunications network and for the provision of the third-generation mobile communications service, file 001-022561, Certification of the General Registry of the General Secretariat for Communications, which listed the candidates submitting tenders, January 12, 2000. Móvil Wed 21, S. A. alleged cross-holdings in the capital of several bidders by Caja Madrid (Public tender ., file 001-022561, Document from the tenderer Móvil Wed 21, February 7, 2000).

Different analysts indicated that UMTS telephony would lead to a concentration in which only five large groups would survive. Indeed, the high bids in the auctions rocked the industrial structure in Europe.

tender with the argument that it would mean violating the rules of law, create legal insecurity and reduce the international credibility of Spain. Uni2, a losing consortium formed with Jazztel, called for the precautionary suspension of the tender, as did Ferrovial. The courts rejected both claims[46].

The leftist parliament accused the Government of three key errors in the awarding of 3G mobile telephony: haste, a total lack of transparency and underselling of public resources with no guarantee of low prices for the service[47]. Recapitulating, they meant to say subordination of democracy to efficacy, of transparent and democratic procedures to an obscurantist decision; turning efficacy into a great political error in perspective, because in the end, their proposal was not the most effective and meant heavy losses for the public treasury. To use a cycling metaphor: "You who intended to be the leaders of the peloton of the new economy are now taking the risk of isolating yourselves from the peloton and having to be picked up by the sweeper car." The socialist inquiry assessed the losses for the country in the billions. The government forgot (and for the Minister of Science and Technology, an economist, this was a lot to forget) that the indirect effects of the knowledge, important in high-tech industries, tend towards geographical localization and that Finland, the other early participant in the concession of licenses mentioned earlier, was much more advanced in the development of a mobile application industry (The Council of Economic Advisers, 2000, p. 2; *DdSCD*, Plenary session and Permanent delegation, 23, 9/13/2000, pp. 996-997 and 7, 5/17/2000, pp. 221-226)[48].

In Spain, 3G did not take off until 2003, in a race with obstacles that would delay the overtaking of GSM until 2008 (Graph 1)[49]. Telefónica charged Ericsson, Nokia and Motorola with the first phase of construction of its UMTS network in sixteen large Spanish cities, with an estimated cost of 20 billion pesetas. It thus repeated its previous experience with technologies in the development of GSM[50]. The first experimental UMTS test was not far

46 Uni2, owned by France Télécom, initially challenged only the concession awarded to Xfera; Ferrovial protested all four awards *(Cinco días*, March 10, 2001). The Minister of Science and Technology held the position of General Manager and Board Member of Retevisión in October 1997.

47 The socialists denounced irregularities in the concession and the violation of the terms and conditions as the result of the lack of information on the conditions and contracts that governed the tenders, and also for accepting aspiring operators who presented tenders for two licenses or in two consortia. They did not refrain from elaborating on several incidents. It would seem that the consulting firm contracted by the ministry had worked for one of the aspiring consortia in the tender and held a meeting with the table to establish the assessment criteria, according to the tender regulations; in addition, a senior civil servant charged with preparing the bidding documents was hired by one of the consortia members in the middle of the tender process. The Izquierda Unida Group qualified the tender process as a "bargain for companies and bad business for the citizens;" a representative of the Mixed Parliamentary Group for the BNG considered it a fiasco *(DdSCD*, Plenary session and Permanent delegation, 25, 9/20/2000, pp. 1.129 and 1.136; 10/26/2000, p. 2.364 and 2.369). Refuting that the low tender prices would translate into the service prices, the socialist representative placed great emphasis on rebutting the minister, an economist, with economic arguments on the service prices, indicating that they do not depend on the submerged costs, rather on competition (*DdSCD*, Plenary session and Permanent delegation, 25, 9/20/2000, p. 2.368 and 2.369). As voiced by the financial media, all the consortia in the UMTS tender had cross-shareholdings, in other words, there was the direct or indirect presence of companies such as BBVA, Caja Madrid, Mannesmann and Kutxa in several operators who submitted bids to the tender process (*Mercadofinanciero*, February 16 and 21, 2000).

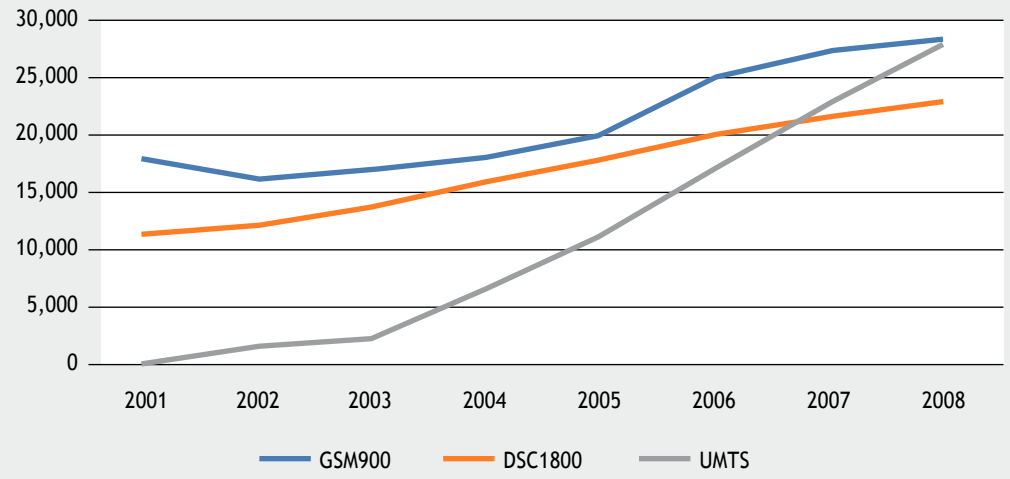
48 The socialist opposition qualified the awarding of the UMTS licenses as the "biggest gift of public money in our economic history" (*DdSCD*, Plenary session and Permanent delegation, 25, 9/20/2000, p. 1.127). Spain recorded the least impact on the budgetary balance of all the countries in the EU granting UMTS licenses in 2000: only one-tenth of a point more than the GDP (Sánchez, 2003, p. 22).

49 According to the testimony of one of the protagonists, in 2004, investors, analysts and experts in marketing agreed in forecasting a brilliant future ahead for UMTS (Navío, J., 2004. Interview with Cayetano Lluch, *Bit*, 147, October-November 2004, pp. 24-29).

50 The chosen cities were Madrid, Barcelona, Zaragoza, Málaga, Bilbao, Las Palmas, Murcia, Valladolid, Córdoba, Palma de Mallorca, Vigo, Alicante, Gijón and La Coruña (*El País*, November 29, 2000). The three manufacturers were required to supply the radio access network and the combined switching structure (packets and circuits), as well as 3G terminals and laboratory systems to conduct interoperability tests among the three providers *(RedesTelecom*, November 29, 2000).

In 1999, Spain approved the schedule of administrative clauses and technical specifications for the tender awarding four licenses to operate third-generation mobile telephone services.

Graph 1
Mobile telephony in Spain. Base stations according to technology type



Source: Own creation, based on data from the National Commission of Markets and Competition, 2016.

behind, and the R&D subsidiary developed user location services, an experimental platform within the UMTS framework to offer 3G services and experiences with local WLAN and Bluetooth wireless technologies and their integration with GPRS mobile technologies. In 2002, the effective deployment of the data services over GPRS took place and the testing phase was concluded for the UMTS network within the time periods promised to the government; in October 2003, Telefónica Móviles made the 'Oficin@ MoviStar UMTS' available to customers, the first pre-commercial third-generation service in Spain, including the 'Pack Degustación UMTS' (UMTS Sample Pack) card and the new telephone terminal, the LG U8150. Coinciding in part with these actions, Quam began to prepare the conditions for the development of its UMTS strategy (OECD, 2004, p. 34; Telefónica, S. A., 2001, pp. 40, 77 and 73; Telefónica, 2002, pp. 27 and 73; 2003, p. 43; *Movilonia*, October 20, 2003)[51].

Accordingly, first Telefónica Móviles and then Vodafone, heir to Airtel in Spain, took the lead in 3G with an experimental version and using PCMCIA cards targeting major clients and not apt for mobile phones, rather laptop computers, which would later arrive in the market[52]. Both torchbearing operators took on different levels of obligations in Spain: Telefónica Móviles committed to €1 billion in infrastructure investments over three years and prior to November 2003, it installed 750 base stations that provided coverage to 40 Spanish cities with combined

[51] The UMTS Sample Pack, available for a price of €299, was the first prepaid 3G data card in Spain (*PCWorld*, December 1, 2004); imitating two Asian countries (Japan and Taiwan) and four European countries (Germany, the Netherlands, Belgium and France), Telefónica introduced the i-mode in mid-2003, a mobile Internet service provided by the Japanese company NTT DoCoMo (OECD, 2004, p. 49; *NTT DoCoMo*, June 25, 2003). During the UMTS launch phase in Germany, Telefónica also chose Ericsson as a provider.

[52] Telefónica Móviles planned to distribute 2,500 PCMCIA (Computer Memory Card International Association) UMTS cards among 500 of the operator's large clients; Vodafone used the SIMO TCI computer trade fair as a platform for its pre-commercial launch of its PCMCIA dual UMTS/GPRS URA (Vodafone Remote Access) card, also aimed at corporate environments, before making it available to residential users (*ComputerWorld*, November 7, 2003).

The acting PP-led government, while the Congress was shut down, awarded licenses to the three existing operators (Telefónica, Airtel and Retevisión-Amena) and to the Xfera consortium, in a process that was far from the transparency seen in Austria and Switzerland.

technology (Nokia packet switching and radio and circuit switching deployed from Ericsson). In a larger amount, the investment announced by Vodafone was reported to be €2.8 billion and 1,000 stations that provided coverage to twenty cities with Nortel Networks technology[53].

We must, however, recognize that UMTS drove the operators into debt and limited their investment capacity[54]. Different barriers arose against the expansion of UMTS. In spite of the relatively low numbers of subscribers, the mobile telephony operators granted the UMTS licenses in Spain committed to investments of €16.296 billion and €7 billion in guarantees. Correcting the gift they were accused of having given, the government established an annual rate or fee of €100 billion over twenty years as compensation for the low amounts collected in exchange for the licenses granted[55]. It is true that it was willing to relax its initial requirements, but without this altering the agreed investment plan in any way (Senate-commission, October 1, 2002, 329, p. 5)[56].

The UMTS licensees, in turn, operated for a while in an environment of uncertainty, in fear that the government's (Ministry of the Economy) zeal to collect funds would lead it to grant new licenses, in spite of the presumed limitation on the available radio spectrum wielded by the Ministry of Science and Technology, thus restricting business expectations[57]. The licensees appeared skeptical regarding the deadlines set by the Government for the commercial launch of the UMTS services in Spain[58].

Following the comings and goings (the so-called 'political and legislative yo-yo' of UMTS in Spain), the Ministry of Science and Technology eased the investment and employment obligations for ten of the obligations that the mobile operators were bound to when obtaining their licenses. The new conditions allowed them to save around €6 billion, 30% of the amount initially committed to for the deployment of networks and infrastructures. Added to this was nearly €4 billion earmarked for the development of applications and services for the new mobile. The ministry also lowered the universal coverage obligations, including the last 15% of those who lived in rural or remote areas. In the very sensitive area of employment, the license holders were exempted from the requirement to create 36,300 direct job positions and more or less the triple that number in indirect jobs. The pact between the ministry and operators did away with the obligation to set up R&D centers, capital venture funds for technology companies and other social projects that represented investments of more than €2 billion. Finally, they eliminated any reference to the prices of the new services[59]. Altogether, the new

53 *El País*, October 30, 2003. During the first quarter of 2001, Airtel deployed UMTS radio base stations in four large cities (Madrid, Barcelona, Valencia and Seville) with Lucent Technologies technology and had plans to extend 3G commercial services over the summer of that same year to 23 cities in which a fourth of the population of Spain was concentrated (*Wireless Internet Telecommunications Newsletter*, March 2001, p. 3; *European telecom*, July 31, 2000, p. 13).

54 *Computing*, June 20, 2001.

55 *El País*, November 8, 2000. For Telefónica, the rate reduced by an annual amount of 25 billion its *cash flow*, **i.e.,** financial resources (Luis Lada in Zafra, 2000).

56 The government spoke of 'more acceptable conditions for the companies' and offered to drastically lower the guarantees; on their behalf, it associated the possibility of sharing networks to the commitment to offer UMTS services as soon as possible *(Cinco Días*, December 17 and November 20, 2002).

57 *El País*, November 3, 2000; the media talked about a true chasm in the government between the proposals made by the Ministry of Science and Technology, which was in favor of limiting the licenses, and the departments belonging to the economic area, which were in favor of expanding them.

58 Telefónica Móviles indicated that the August 1, 2001 deadline was five months earlier than that recommended by the European Union and its fulfillment was subject to the absence of any technical barriers, which were emerging in terms of the availability of the terminals and the lack of services they promised (fast Internet connection, videoconferencing and e-mail) (*La Vanguardia*, August 29, 2000).

59 The bulk of the investment will be concentrated in the first five years: €2.3 billion in the first two fiscal years and 4.5 billion over the next three.

In Spain, 3G did not take off until 2003, and did not overtake GSM until 2008. Telefónica charged Ericsson, Nokia and Motorola with constructing the first phase of its UMTS network.

conditions decimated the commitments associated with the concessions and thus compromised the objectives of universal mobile telephone coverage and the development of the information society that were so repeatedly proclaimed.

5. The role of Spain in the European implementation of third-generation mobile telephony

The third generation of mobile telephony had some supranational dimensions built into the UMTS standard. At this point, we will turn to globalization. As a historic telecommunications company, Telefónica focused its strategy along two priority lines, consisting of maintaining their leadership in the landline telecommunications market to ensure revenue generation and to guarantee its future as Spain's chosen communications provider (Linares, 2001). Stipulated by another strategist of the operator, it was a plan based on six central ideas that referred to geographic positioning, company structure, offer and financial performance. Specifically, it implied maintaining leadership in Spain, growing organically and territorially in Latin America, expanding in Europe by taking advantage of the concession of new licenses, functioning as a unified company, generating scale economies to reduce costs, developing the mobile Internet market with content applications and strengthening their financial situation (Luis Lada, in Zafra, 2000).

During the 1990s, the expansion by Telefónica throughout Europe was very limited, as it lacked any implementation in the area, except for small shares in Portugal and Austria. In the opinion of Plaza (2000), this was a great gap in Telefónica's strategy, which made it very vulnerable within the EU. The situation changed after 2000, with the acquisition of UMTS mobile telephony licenses in several European countries (Calvo, 2016, p. 41)[60]. In Central Europe, Telefónica controlled an Austrian company providing telecommunications services to businesses, and through Terra Mobile (51% owned by Telefónica Móviles and 49% by Terra Networks), the Finnish company Iobox, the leading independent portal and content aggregator in Europe[61]. Towards the end of 2006, the tangible and intangible investments of the Telefónica Group totaled €5.067 billion, divided between Telefónica de España (906 and 143), Telefónica Latinoamérica (652 and 85), Telefónica Móviles (1,072 and 229), Grupo O2 (1,255 and 277), Grupo Český (108 and 34), Telefónica Contenidos (36 and 1), Atento (17 and 2) and Resto y eliminaciones (Remainder and eliminations) (239 and 11)[62].

It has been said that Telefónica's access to Europe was quick and decisive, and the figures back this to a certain degree, since in only two years (between 2004 and 2006), the continent went from contributing slightly more than 4% of the company's income to 26%. A closer examination indicates some slow starts, because Telefónica had already been operating for years

60 Some brief references to these episodes seem to reduce the initiatives in Europe to a mere parenthesis, which demonstrates the need to reconstruct this interdisciplinary story we referred to at the start. For Fernández and Mielgo (2008, p. 85), for example, the UMTS licenses won in Germany, Italy, Austria and Switzerland were projects that we ultimately scrapped due to the failure and non-fulfillment of expectations that said technology had generated.

61 Iobox originally pursued the provision of strongly localized services for each country. Iobox was financed in two successive rounds in the amount of €3.1 and 13 million (January and December 1999), in the first round by SFK Finance, Eqvitec Partners, Alto Berkeley Investments and Capman Capital Management, and in the second round by Morgan Stanley Dean Witter Capital Partners. In late 2000, Terra Mobile had a total of 3,052,802 registered subscribers and operated in the markets of Finland, Switzerland, Germany, the United Kingdom and Spain (Telefónica, S. A., *Informe Anual*, 2000, p. 32; Shi, 2004, p. 120; Koskinen and Rouhola, 2000, pp. 1-2). Iobox represented the addition of €233.45 million in the consolidation after late 2000, out of a total of €5.21363 billion (Telefónica, S. A., *Informe Anual*, 2000, p. 102).

62 Telefónica, S. A., *Documento de Registro de Obligaciones y Derivados,* Appendix IV of Regulation (EC) No. 809/2004 from the Commission on April 29, 2004, p. 24.

Thereafter, Telefónica Móviles and Vodafone, Spanish heir to Airtel, took the lead in 3G with an experimental version using PCMCIA cards aimed at large clients.

in different segments of the European market. What occurred was an important step forward, but not one free of prior failures.

Faced with a loss of market share to the competition in its traditionally privileged space, Telefónica saw UMTS third-generation mobile telephony as the 'window to Europe.' Knowing that this market would position it among the top world operators, it decided to take its chances abroad in the new market segment.

As indicated above, one of the company's strategic objectives at the start of the millennium was to obtain licenses to operate mobile services in Europe, using UMTS technology. The UMTS-based strategy, conveyed by Telefónica Intercontinental as the instrumental company, was pan-European in nature, giving priority to the markets in large countries (United Kingdom, Germany, France and Italy) and one of the most advanced, namely Switzerland. Telefónica linked its technical success in 3G telephony not only to obtaining the licenses and its operation in 2002, but also to strategic actions during this year and the following one. Such actions included, first of all, the creation of a pan-European operator with two parallel structures – one on a European scale, with strategic partners, in which Telefónica would have a majority shareholding, and another on a local scale in each country. To this, the provision of wireless-Internet services was added by establishing new companies with partners in UMTS or by acquiring existing companies. Thirdly, the strategy involved the acquisition of alternative mobile operators in the main European countries prior to the launch of UMTS, as a customer base. The strategic actions continued with the creation of a single mobile brand associated with UMTS[63].

As materialization of the strategy, in 2000, which was especially intensive in terms of activity, Telefónica conceived a consortium with BBVA, La Caixa, Banco Zaragozano and Abengoa to obtain third-generation mobile telephony licenses in the main European countries, among them the United Kingdom, Germany, Italy and France[64]. To finance these operations, Telefónica took out a syndicated loan from two Spanish banks and five foreign banks in the limited amount of €8 billion (1.33 trillion pesetas)[65]. That same year, BBVA and Telefónica

63 Telefónica, *Informe Anual*, 1999, p. 32. One of the directors points to the precocity in declaring itself a global player in a market with a restricted club of global players. "It is clear that in order to be a global player, it is necessary to have a strong presence in Europe: Interview with Alfredo Acebal, CEO of Quam, February and September 2002, in Picot and Doeblin (2013), p. 97. The analysts at McKinsey, the banking institution involved and famous law firm in London, reported that the average revenue per user (ARPU) could be between €60 and €80 (Conversation with Fernando Panizo, February 1, 2017). The oral history focuses the decisive stakes set by Europe on the link between privatizations and free competition, which opened the way for the mobile business (Conversation with Luis López-van Dam about Telefónica's globalization process, 4/18 and 5/13/2013). Far from unanimity, a sector of Telefónica positioned itself against the purchase of UMTS licenses in Europe.

64 CNMV, Significant event, 6.603, 3/31/2000; *Network World*, April 3, 2000. The BBVA had a 9.1% holding in Telefónica's capital, greater than that owned by Caja de Ahorros y Pensiones de Barcelona (5.01%) (Spanish National Stock Exchange Commission, 7/15/2000).

65 CNMV, Significant event, 8.754, 8/22/2000. Banco Santander Central Hispano (BSCH) and Banco Bilbao Vizcaya Argentaria (BBVA); ABN AMRO Bank N.V., Chase Manhattan Bank, Citybank/Schroder, Dresdner Kleinwort Benson and Salomon Smith Barney. The loan was divided into two portions of €6 billion (998.316 billion pesetas), with a term of 364 days, extensible for an additional year and a second portion of 2 billion (332.772 billion pesetas) with a stipulated term of three years. Telefónica lost 4.7% on the stock market, closing at less than €22 (*ComputerWorld*, August 23, 2000). The oral history of Telefónica perfectly records the colossal amounts of money sunk into the operators, which have led to problems that have yet to be solved, as occurred with Yoigo-Sonera (Conversation with Fernando Panizo, 2/1/2017). Xfera (Spain), Quam (Germany) and Ipse (Italy) threw in the towel even before beginning to provide services (*El País*, September 29, 2002). Xfera sold its UMTS license to Abengoa in an effort towards diversification in the information and telecommunications sector; this company, in turn, through its subsidiary Telvent Sistemas y Redes purchased for €25 million 3.71% of the capital of Xfera, a percentage that it increased to 5.4% with the purchase of shares in Xfera that were in the hands of Vivendi (*Cinco Días*, December 30, 2002; CNMV, Significant event, 42.988, 6/30/2003).

The UMTS licensees operated for a while in an environment of uncertainty, in fear that the government would knuckle under to the fundraising pressure and award new licenses, restricting business expectations.

forged a broad alliance that included UMTS business, along with another thirteen joint actions, among which the Telefónica Group's holding in the bank Unoe.Bank, S. A. stands out.[66]

However, the agreement, a lifeline for a very worn Villalonga, 'lacked concrete resolution' and BBVA ended up with a questionable participation in the consortia for the UMTS licenses[67].

In a similar manner, the competition began to take shape with the transversal alliance between the electric companies and telecommunications companies (Endesa with 38.9% of the capital, Unión Fenosa with 23.6% and Telecom Italia with 37.5%. Under the name of Auna, the new rival consortium would cluster together the holdings of each of the members in the telecommunications sector in Spain[68].

Telefónica, with its mobile subsidiary, subordinated the entry into the European market to the profitability of the investment, along with the reduction of risks through the alliance with technology and financial partners that would limit the financial exposure of the company, without losing control over the operations. In the search for allies, the choice of local partners took on great importance[69]. However, it must be said that the entry strategy took on a different shape according to the countries it planned to enter.

Telefónica decided to abandon the British auction due to the high price reached and the fact that BBVA, its partner in a strategic alliance, was opposed to any further bids by the operator[70]. Following the British episode, the main European governments remodeled the license concession system, requiring candidates to adapt to the new circumstances.

The German market represented both an opportunity and a challenge, because the experience already acquired in other countries could provide a privileged position for the launch of its operations. Telefónica began to assume positions in the IP network and Internet portal segment, thanks to its entry in mediaWays and in Terra Lycos, the second largest IP network and Internet portal operator in Germany, respectively, as well as in Iobox, the mobile Internet portal acquired by Terra Mobile (Rozas, 2003, p. 45; Telefónica, *Informe Anual*, 2000, p. 80; *PCWorld,* October 1, 2000)[71]. To compete in Germany, Telefónica, now without the support of important banking and infrastructure companies (BBVA, La Caixa, Banco Zaragozano), joined forces with the operator

66 Telefónica and BBVA created the Monitoring Committee for their alliance with collegial senior management (Emilio Ybarra and Francisco González for BBVA and J. Villalonga for Telefónica) and ten members distributed evenly. A coordination unit was also created for the work groups, under the direction of Pedro Luis Uriarte and Luis Martín Bustamante. The first results were two collaborative agreements related to the new economy. In line with the alliance's approach, the partners began negotiations with other potential candidates with a compatible strategy. On its own, BBVA singed an agreement with Logista, Terra and the German group Bertelsmann to develop e-commerce and logistical operations derived from it (CNMV, Significant event, 6.622, 4/6/2000).

67 To determine the possible effects of the BBVA alliance on competition, the Ministry of Economy opened a case that was dismissed by the Competition Defense Service (*El País,* February 24 and May 24, 2001).

68 The consortium, worth 3.2 trillion pesetas, invited Banco Santander Central Hispano (BSCH) to join (*El País*, April 7, 2000). Shortly afterwards, it was subjected to restructuring.

69 Telefónica, *Informe Anual*, 2000, p. 80; CNMV, Significant event, 6.603, 3/31/2000.

70 CNMV, Significant event, 6.709, 4/17/2000.

71 Creation of Terra Lycos (Jelassi and Enders, 2005, p. 401). The auction design allowed each eligible participant to bid for two or three blocks of 5 megahertz of the spectrum, out of a total of 60 megahertz up for sale (*RCR Wireless*, May 1, 2000). A bidder could win two or three portions, which meant that there would be between four and six winners. Seven bidders participated in the auction, the largest of which fought tooth and nail for three lots and the result of the fifth winner, but the two strongest potential participants refused to abandon the auction. At the last moment, in light of the pressure from the capital markets, the largest holders agreed to reduce their demands from three to two lots and to end the auction with two new participants (Cramton, 2013, p. 6).

In the 1990s, the expansion of Telefónica throughout Europe was very limited, as it lacked any broad implementation in the area. The situation changed after 2000, with the acquisition of UMTS licenses in several European countries.

Orange and the Finnish company Sonera (Xfera's partner)[72]. In August 2000, the 3G Group, 57.4% of which was owned by Telefónica Móviles and 42.6% by the Finnish company Sonera, obtained one of the six UMTS licenses in Germany through the instrumental company Marabu, with a cost of €8.471 billion (*Official Journal of the European Communities,* C 305/8, 10/25/2000)[73].

Unlike the preferred auction processes in the United Kingdom or Germany, the French government brought out four third-generation mobile telephony licenses to be awarded in a tender process ('*sousmission comparative*' or '*beauty contest*') that rewarded different qualitative criteria, such as the scale and speed of deployment of the network. To the despair of the authorities, who counted on an avalanche of candidates, only the three existing mobile operators entered the tender (France Télécom, SFR [Vivendi] and Bouygues Telecom, along with Telecom Italia). Other groups, among them the American MCI Worldcom group, the Swedish Tele2 and Telia, the Australian One.tel and the British Virgin merely studied an offer[74]. While not an operator, Suez Lyonnaise des Eaux considered participating along with several possible candidates for a license, including the Dutch company KPN, Telefónica and the Canadian company TIW. The Spanish operator decided to join the project in a holding with the capacity to incorporate one or more minority partners, and a shareholding of 40%[75]. However, the great alliance that was negotiating opted for the Dutch company KPN, as we will see. Both companies clearly understood that UMTS was vital for their future on the old continent[76]. The ST3G consortium resulting from the agreement with Suez decided to withdraw from the auction due to the excessively high cost of the license and the large amounts to be invested. Others followed suit (Bouygues Telecom), and so only liza France Télécom and SFR were left. Next, Telefónica demonstrated its interest in the two UMTS licenses that were left to be assigned, as did the Japanese company NTT DoCoMo and Deutsche Telekom[77].

Access to Italy took place through an agreement with the telecommunications service partner ACEA to participate jointly in the tender awarding five UMTS licenses. The auction

72 CNMV, Significant event, 21.979, 4/27/2000; *El Mundo*, May 7, 2000.

73 Other sources (*Computerworld*, August 18, 2000) indicate costing variants: 1.4 trillion pesetas (€8.409 billion); a return rate of 22-23% was expected, with a 50/50% initial debt-capital structure (CNMV, Significant event, 24.278, 8/18/2000); the other successful bidders were T-Mobil, Mannesmann, E-Plus, Mobil Com and Viag Interkom (Little, 2001, p. 5). According to some specialists, the purchase of the UMTS license in Germany, among others, did not produce financial gains (Berne and Pogorel, 2004, p. 13).

74 *La Tribune*, October 20, 2008; *RCR Wireless News*, June 12, 2000. In the French tender, all the bidders committed to paying an initial spectrum quota of €4.95 billion (Hocepied and Held, 2011, pp. 26-30).

75 Suez Lyonnaise des Eaux (SLdE), a candidate that had repeatedly failed in mobile telephone bids in France, was well-positioned to win one of the four licenses in play. SLdE transferred a 10% holding in ST3G to the Groupe Arnault, member of the FirstMark Communications consortium, the national radio local loop operator (*L'Usine Nouvelle*, 2.757, 11/23/2000). The communication by SLdE was estimated to be worth 40 billion francs (€6 billion), more than 15% of the group's revalued assets. Alongside SLdE in the communication were Lyonnaise du Câble (50.1%), the television channel M6 (35.5%), the TPS satellite (25% directly and 25% through M6) and the cable channel Paris Première (54% directly and 11% through M6). The media reminded that Telefónica had its Internet company Terra Networks, with a market cap of around €26 billion, 30% of the total value of its parent company (*La Tribune*, October 20, 2008; *Le Monde*, February 1, 2000). Suez Lyonnaise des Eaux maintained a presence in Spain through Tractebel.

76 CNMV, Significant event, 21.979, 4/27/2000; *El Mundo*, May 7, 2000. By 1996, there were 400,000 mobile telephones in Spain and six years later, this figure reached 31 million (Senate-commission, October 1, 2002, 329, p. 5). Telefónica had twenty million mobile telephone subscribers around the world in 2000. Throughout the 1980s and early 1990s, Spain lagged behind the large EU countries in terms of investments in telecommunications. The expansive profile of mobile telephony in the country resembled that of France during the second half of the 1990s (Girard and Gruber, 1996, pp. 18-19).

77 *Économies et sociétés*, 37, 2003, p. 5; *Wireless*, February 2001, p. 5; Telefónica (2001), p. 12; *Clubic*, February 2, 2001; *El País*, December 11, 2000. Each of the successful candidates in the French process was required to pay €4.950 billion (823.61 billion pesetas) per license, so that the overall amount of the process reached €19.8 billion (3.29 trillion pesetas). Sources from Suez Lyonnaise indicated that their alliance with Telefónica was limited for the moment to France, although it did not rule out participating in the UMTS license concession in Belgium with the Spanish operator (*ComputerWorld*, August 23, 2000). The French government sought resources to continue to finance retirements and the state deleveraging process; in the opinion of some experts, the French government, judging from what could rationally be anticipated, simply reproduced the probable results of an auction (Curien, 2002, p. 152).

Telefónica subordinated the entry into the European market to the profitability of the investment and reduced risk through the alliance with technology and financial partners, without losing control over the operations.

underscored the appearance of alliances of operators from other countries who had arrived in the market; we are referring to the axis formed by Telefónica/Sonera, partners in a UMTS system in Italy[78]. But the vehicle of entry was the IPSE 2000 consortium, of which Telefónica Móviles owned 39.3%, Sonera held 19% and Atlanet and Banco di Roma had an identical percentage. In November, the consortium obtained one of the two 2x15+5 MHz UMTS licenses (the other three were 2x10+5 MHz) for an overall amount of €3.27 billion[79]. The "winners" bore the burden of $7.7 billion in payment per license and at least another $8 billion in investments in an enormous and expensive telephony network, along with a heavy debt, even though the only thing they received in exchange was permission to compete in a market in which earnings were far off and hypothetical (Chorafas, 2016, p. 126).

In the case of Austria and Switzerland, Telefónica obtained both UMTS licenses for an amount of €117 and €33 million, respectively. The British lesson on high prices led to the emergence of price reduction strategies through cooperation in offers in other countries (Van Damme, 2000, pp. 4-8)[80]. This happened in Switzerland, where Telefónica repeated the consortium formula in an alliance with Sonera and the Australian company One.Tel (Team 3G), which ultimately left the Spanish company standing alone. The low revenue resulting from the Swiss auction was due to several circumstances. To begin with, it occurred late as compared to the others, and was further characterized by a lower number of bidders as the result of withdrawals and mergers. Four of the nine qualified bidders withdrew from the proceedings, while two of those remaining announced merger plans a few minutes before the auction[81]. Finally, the price

78 Telefónica had interests in the group through its 34% package in the Atlanet data division, the lead group of Acea that previously had control over Ipse; in Atlanet, Telefonica Data and Acea joined the Fiat group and the group belonging to the Agnelli Ifil family (*Total Telecom*, August 23, 2000).

79 *Official Journal of the European Communities* C 349/7, 6-12-2000; CNMV, Significant event, 21.717, 4/14/2000; *Total Telecom*, August 23, 2000. The chronology indicates August 23 and October as the dates when the IPSE 2000 consortium was founded and one of the two UMTS licenses in Italy was awarded, respectively (Telefónica, 2001, p. 12; Telefónica, *Informe Anual*, 2000, p. 82). ACEA, leader in the electricity and water sector, provided telecommunications services in Rome and Lazio, in association with Telefónica. Other figures on the holdings of the partners in the IPSE 2000 consortium: Telefónica through Telefónica InterContinental (39.25%), Sonera (19%), Atlanet (12%), Banca di Roma (10%), Goldenegg (4.8%), Xera (5%), Planet Mobile (0.5%), Falck, along with a group of Italian municipalities (3%) (*Newswire*, September 11, 2000). ACEA-Telefónica SpA, subsidiary of the Telefónica Group in Italy, announced its intent to merge with Telexis, a subsidiary of the FIAT Group to provide business services, particularly Internet-related services. The early withdrawal of Blu, the lowest and weakest bidder, lowered the price of the operation and triggered a complaint by the Italian government against Blu for alleged violation of the rules (Heuvelhof *et al.*, 2009, p. 129). Consortium of companies, the most important of which were: Autostrade, a state SpA company, had control over 32%; British Telecom owned 20%; Benetton had 9%; Mediaset, the private Italian company in the television market, and Bnl, one of the largest Italian banks, had 7% (Bartolini, 2005, p. 10).

80 Half of the expected revenue was obtained in the ascending price auction for UMTS licenses in Austria, halted twice by the government for possible collusion, which was expressly prohibited (Sokol, 2001). Licensees in Austria: T-Mobile Austria, GmbH, 3G Mobile Telecommunications, GmbH, Mobilkom Austria AG (subsidiary of Telekom Austria), Hutchison 3G Austria, GmbH, ONE, GmbH and TRA 3G Mobilfunk, GmbH (PRESS RELEASE No 44/07, Judgment of the Court of Justice in Case C-284/04 and Case C-369/04 T-Mobile Austria, GmbH and Others v Republik Österreich, Hutchison 3G UK, Ltd and Others v Commissioners of Customs & Excise; The award by the state of 3G mobile telecom, *CJE/07/44, June* 26, 2007). The historic operators had the advantage of the pre-existing 2G networks, some of the components of which could be used in the 3G system. As a matter of fact, the potential participants had strong incentives to partner with the holders, which is what eventually occurred (Sokol, 2001). During the summer of 2000, Mobilkom Austria AG deployed the first comprehensive GPRS network in the world, the packet switching data support medium for GSM (Taferner and Bonek, 2002, p. 3).

81 *Network World*, September 4, 2000; *Wall Street Journal*, June 6, 2000; Sokol, 2001, p. 24. The Swiss regulator halted the auction when the number of bidders for the four licenses was reduced to only four after the announcement of the merger of the Swiss mobile telephone companies diAx and Sunrise. Telefónica expressed its displeasure and rejected the merger of the operators as an excuse (*SwissInfo*, November 26, 2000). The auction resumed in response to the pressure from businesses and the public (Gruber, 2005, p. 257). In 2006, The Federal Communications Commission (ComCom) revoked without compensation the unused 3G Mobile AG UMTS license for a violation of the coverage conditions by the licensee. At the same time, ComCom rejected the 3G Mobile requests related to the transfer of the license to one or more existing UMTS licensees (ComCom, **April 13, 2006).**

Not everything was a success and even when Telefónica did succeed, the priority stake on the main markets in the EU failed to produce the desired yields. The massive financial resources required a mandatory selection of objectives.

was affected by the new financial situation that the UMTS auctions had helped promote, i.e., generating an enormous debt that made it more difficult to later win licenses[82].

Not everything was a success, and even when Telefónica did succeed, there was a delay between the priority bid for the main EU markets (the UK, France, Germany and Italy) and the effective yields, which left out the UK and France. Furthermore, the vast amount of financial resources required to set up the networks and implement the service imposed an obligatory selection of objectives[83]. This explains why Telefónica bowed out of the auction for five third-generation licenses in Poland, in spite of having originally considered this market as strategic and even having taken the first steps with the creation of a consortium, along with the construction company Ferrovial, Futuro.com and the local company Polpager. A multi-million euro debt, fueled by investments in licenses in Italy and Germany, made expense containment recommendable. In addition to the financial exposure were some especially onerous conditions, among them the subordination to local capital and the concentration of the payment in the first fourteen years of a license granted for twenty years[84].

Telefónica was knocked out of the tender in Sweden, one of the most advanced countries in the world in mobile communications and Internet, a historic position left over from its significance in the early moments of telephony[85]. The Scandinavian country sought the largest number of licensees to best meet the need for consumer services and ensure competition among the 3G operators (Larsson, 2008, p. 24). Telefónica competed with nine international groups, according to the well-known scheme of a consortium with local partners, i.e., through the Reach Out Mobile AB consortium, made up by the Finnish operator Sonera and the Swedish investment fund Industri Kapital. The competent authority evaluated the proposals in a double phase, based on two sets of criteria: financial capacity/technical and commercial viability in the first phase and coverage in relation to the area and population and the deployment speed of the networks in the second phase. The concessions were granted to the Swedish operators Europolitan, HIG3, Tele2 (Netcom) and the Orange Sverige consortium. The Reach Out Mobile AB consortium was ruled out for the lack of "technical reliability," but in all reality, it was due to the lower level of commitment in terms of building base stations and investment. The decision was challenged before the Tribunal, alleging that it was improper to reject the application for possible problems in the project organization and network construction, since any license holder would face identical problems (Andersson, Hultén and Valiente, 2005, pp. 577-593; Curwen, 2002, p. 82; *El País*, December 17, 2000)[86].

82 In just five years, the net debt of mobile telephony companies nearly quintupled: it soared from €7.4 billion in 1998 to €36 billion in 2002 (Preissl and Müller, 2007, p. 447). The specialized financial press insisted on this runaway debt for licenses (*The Economist*, May 3, 2001). Some assigned greater responsibility in terms of debt to the imprudent acquisitions and the general/creative accounting than to the license fees, no matter how burdensome they were (*The Guardian*, August 27, 2002).

83 Conversation between Luis López-van Dam and the author about Telefónica's globalization process, 4/18 and 5/13/2013.

84 No doubt a reflection of the harsh conditions, the number of candidates was limited to the three existing mobile telephony operators, which forced the ministry to cancel the tender. Telefónica advocated four UMTS licenses (OECD, 2002, p. 31). Futuro.com abandoned the consortium created with Telefónica, considering the conditions proposed by the Spanish operator to be unacceptable (*Bakier*, 12/1/2000; *Baquía*, 12/4/2000); Polpager joined the Elektrim Telekomunikacja holding; Polska Telefonia Cyfrowa (PTC), leader during the GSM era, continued as such from then on.

85 CNMV, Significant event, 8.793, 9/1/2000.

86 Telefónica InterContinental had a minority share in the consortium (20%) as opposed to 45% by the Sonera Corporation and 35% by Industri Kapital (Telefónica, 2001, p. 12). Sweden, with three second-generation mobile telephone operators, enjoyed a mobile telephony penetration rate of nearly 65%; to participate in the tender, candidates needed to pay 100,000 Swedish kroner (1,940,000 pesetas) to cover administrative expenses and the successful bidder undertook to pay the state a 0.15% royalty from its income until 2015, when the license expires (*NetworkWorld*, September 4 and December 15, 2000). The Swedish tender failed in its attempt to effectively resolve the users' aspirations and Sweden failed miserably in applying the ambitious coverage criteria (Welin, 2006, p. 2).

6. The companies: from successful bidders to mobile network operators

The introduction of third-generation UMTS in Europe was delayed by the financial crisis in telecommunications due to the astronomic costs of licenses for mobile telephony operators. The enormous investments required to build the infrastructure were combined with serious financial problems in the sector, with negative effects on the deployment of the 3G networks in the area (Palmberg, 2006, p. 95)[87].

Our analysis should go beyond merely listing the concessions, which is a very common trend, and delve briefly in how they operated. We will do this for several countries, by way of example, but not without first indicating that two years after the purchase of these expensive licenses, no operator was providing UMTS services. The relative loss in share value varied from a minimum of 55.4% for Telefónica to a maximum of 95.6% for KPN (Columbus, 2004, p. 4).

We have the self-assessment of Telefónica regarding its early actions in Germany, Italy, Switzerland and Austria. Since day one, the operator channeled the management of the companies holding 3G mobile telephony licenses to take advantage of the synergies and scale economies, with limited financial exposure. Throughout 2001, it negotiated the supply and finance contracts with suppliers, with noticeable progress in the interconnection agreements with the other operators to share part of the network infrastructure needed for UMTS (Telefónica, *Informe Anual*, 2001, p. 40).

Very soon and in full agreement with the explosive nature of the business, the situation changed. The market conditions (severe downward corrections in the estimates of the demand for 3G services), technology (once again, a delay in the availability of UMTS technology), competition (the emergence of barriers to the entry of new candidates due to an increase in penetration in the European markets of already established operators), along with financial and regulatory aspects pushed Telefónica to revise its business model and redefine its short- and medium-term objectives in Europe. During the last quarter of the year, Telefónica totally eliminated exposure in three European countries (Germany, Austria and Switzerland)[88].

If we analyze by country, in Germany, the deployment of UMTS was delayed by the lack of terminals, among other reasons. Based on agreements for roaming and the exchange of infrastructures with another operator (Deutsche Telekom AG) and with the authorization of the German regulator, Telefónica's 3G Group debuted in late 2001 as a virtual mobile operator (VMO), with GSM/GPRS technology. Later, in light of the operating and financial results, Telefónica Móviles realized that the results of the 3G Group in its first stage were noticeably distant from its original objectives. These deviations materially affected the expected profitability of the company in the context of an important deceleration of growth of the

87 The massive indebtedness of the European operators with the banks and financial markets unleashed a vicious circle: downward valuation of the operators, successive increase in the debt and capital cost, negative impact on the investment capacity and profitability, and the crash of the operators' stock market value. Meanwhile, in the issue of obligations for 2000, Telefónica was generally positioned below the main European operators (including the 64.7% of Vodafone, the 23.9% of Deutsche Telekom and the 59.64% of British Telecom), so they suffered from less negative effects (*Didier and Lorenzi,* 2002, pp. 86-87).

88 The new valuations obtained from the plans in Germany, Austria, Italy and Switzerland required accounting for extraordinary provisions, attributable to the recovery of assets, and providing for restructuring expenses. It thus made possible a strong generation of cash flow in Telefónica Móviles and flexibility to optimize its strategy. These measures were pioneering in nature in Europe and well-received by the market; in 2002, the investment in wireless telephony fell by 50.7%. The extraordinarily negative net results caused by the recovery of assets, added to the UMTS restructuring expenses in Europe were estimated at €4.9582 billion (Telefónica, *Informe Anual,* 2002, pp. 48-49 and 214).

The market, technology and competition, along with financial and regulatory aspects, pushed Telefónica to revise its business model and redefine its objectives over the short and medium term in Europe.

wireless market in Germany. As a result, Telefónica Móviles and its partner Sonera completely halted the commercial operations of its Quam brand in light of the very low expectations of generating value for the shareholders of the 3G consortium. Another telecommunications victim, Quam declared bankruptcy, no doubt explained by the costs of technology investments and the UMTS license[89].

In Italy, the IPSE 2000 shareholders opted in 2002 to postpone the launch of commercial operations and to restructure the company. In Switzerland and Austria, no pertinent commercial agreements had been signed, including 2G roaming agreements, network distribution agreements and supplier financing. With all of this, in Austria, it did not rule out a possible alliance though a takeover of a UMTS operator or cooperation with other UMTS suppliers. The acquisition formula or the alternative of cooperation were also considered for other countries, such as Germany, Switzerland and Italy (Securities and Exchange Commission, 2003, p. 88; Lemstra and Melody, 2014, p. 175; Picot and Doeblin, 2013, p. 95; *Telecompaper*, April 2, 2003)[90].

In the first half of 2002, the general UMTS market conditions suffered revealing changes from the quadruple competitive, technological, financial and regulatory perspective. These changes obligated Telefónica Móviles to revise its European strategy. To start with, it had to assume the clear resistance by the European Commission to any relaxation of regulations[91]. The delay in the technological development of UMTS suppliers, as well as the uncertain competitive capacities of UMTS in terms of the existing technologies caused a constant delay in commercially viable UMTS technology, which did not foster a fast and large-scale accumulation of 3G networks. As a result, the operators focused on building their 3G networks in the same areas – the major metropolitan areas of each country – to meet the licensing requirements and their own commercial needs, in such a way that the network distribution agreements lost effectiveness. In a nutshell, the important cost savings derived from network distribution agreements were reduced to nothing, while the financial resources necessary for network deployment increased[92].

The general delay in the introduction of a commercially viable UMTS technology was also due to the lack of UMTS mobile terminals, which were reduced to a small number of prototypes with technical problems, as well as problems with the hardware and software of the network

89 *DW Akademie*, October 14, 2002.

90 Bartolacci and Powell (2012, p. 180) did indicate roaming agreements in Austria. GPRS (general packet radio service or 2.5G), the natural evolution of GSM to 2.5G, tolerated voice and high-speed data transmission. A VMO is a mobile operator that, lacking a network, purchases capacity wholesale from operators owning physical networks and then sells it to its customers. Telefónica chose NavisRadius (TM) software from Lucent Technologies to manage its new UMTS network, as well as its GSM and GPRS networks (*UMTS Forum*, January-March 2004).

91 Concerning regulation, see Faulhaber, Madden and Petchey, 2012, pp. 247-267.

92 Regarding the combination of delays in 3G network deployment and financial problems, see Louta et al. (2003). Among the technical problems of 3G telephones and the base stations were the high energy consumption and increased software content, as these were in fact pocket computers. The demand for hybrid telephones (3G telephones capable of reverting back to 2G) made it even more difficult to manufacture third-generation terminals and meant delays in their availability. The financial repercussions of the delay included the deterioration of the share price and the added difficulties to raise money due to the negative weight of the debt on their credit ratings. The threat of more debt hovered over the operators, particularly the new participants. In the device manufacturers, the operators found various ways to alleviate the harshness of the 3G deployment conditions. One consisted of "supplier financing," in which they loaned money to client operators. Loaning up to 200% of the cost of the hardware meant that the suppliers accepted risks, especially in loans to new operators yet to generate any revenue. Some of them compensated the delay in the 3G launch by becoming resellers of the existing 2G networks belonging to other companies. This strategy provided short-term revenue and allowed the new participants to gradually introduce their 3G infrastructure by offering their subscribers hybrid devices. This implied as a logical conclusion "network exchanges" (network-sharing), in which two or more operators agreed to share part of their 3G infrastructure to speed up the deployment of their 3G networks (*The Economist*, May 3, 2001).

The uncertainty regarding the commercial reality of the UMTS technology and the evolution of the services that it must support made it advisable for Telefónica Móviles to revise downward the demand for 3G services.

equipment. This general delay permitted the historic operators to soften the 'migration' to the UMTS technology and lifted entry barriers for new operators. The delay situated the main European markets on the brink of saturation and hindered new operators in their attempt to capture lesser value customers or users who were still without service, even for those who used the preceding technologies, i.e., GSM. In spite of the delay, Telefónica gave validity to the UMTS technology as long as there was a small number of operators in each country. The difficulty by new operators to gain access to mature markets and a level of revenue per user that was lower than previously estimated underscored the importance of a minimum market quota to neutralize the cost pressures and achieve the required performance[93].

In short, the uncertainty about the commercial reality of the UMTS technology and the evolution of the services that it needed to support made it advisable for Telefónica Móviles to revise downward the demand for 3G services. To prepare the financial statements for 2001, Telefónica Móviles had compared the accounting value of the licenses to the financial projections included in the business plan and considered the investments made so far to be recoverable. In July 2002, the company agreed to revise the value reflected on its balance sheet for its assets in Germany, Austria, Italy and Switzerland. According to this examination, the financial statements on June 30, 2002 incorporated an extraordinary net provision in the amount of €4.902 billion, of which 310 million corresponded to the provision for restructuring expenses in these countries and €4.592 billion to the provision for the restructuring of assets (tangibles and intangibles) allocable to Telefónica Móviles (Telefónica, 2002, pp. 4 and 6; Khosrowpour, 2004, pp. 132-133)[94].

The first transfer of the UMTS spectrum between companies in Europe did not take long to arrive. In December 2003, Telefónica Móviles España sold to Mobilkom Austria Aktiengesellschaft & Co KG all of its share in 3G Mobile Telecommunications, GmbH, the Austrian subsidiary of Telefónica Móviles España, holder of the UMTS license, for €13.65 million[95].

7. Conclusion

This article offers a succinct report on the implementation in Europe of the third generation of mobile telephony and its arrival in Spain from a multidisciplinary perspective. The work sheds light on the effective operation of the European telecommunications market, in which certain supranational regulations were combined with the maintenance of prerogatives in the hands of member states for the application of said guidelines.

In Europe, the third generation of mobile telephony was introduced under a common technical standard and regulation, but according to specific conditions imposed by the nation-

93 We followed very closely the Securities and Exchange Commission (2003), p. 89. Although technically very different from the GSM, the economic and competitive development of UMTS could depend closely on the previous GSM market structures (Kruse, 2004, p. 185). Telefónica Móviles España obtained two GSM 900 licenses for fifteen years, which ended in 2010 and 2020, one DCS-1800 license for 25 years, which ends in 2023, and a UMTS license for twenty years, which expires in 2020. DCS (Digital Cellular Service) 1800 was an implementation of the GSM standard that operated on the 1800 MHz frequency (Securities and Exchange Commission, 2005, p. 36).

94 Independent experts advised Telefónica Móviles in the evaluation of the business plans of the Group operators in Europe (Securities and Exchange Commission, 2003, p. 87). The losses generated in 2000-2003 have been estimated at between €1 and €2 trillion; the sum of €9.1 billion gave Telefónica the fifth position among the companies with the greatest expense on UMTS licenses (the so-called gorillas), behind Vodafone, British Telecom, France Télécom and Deutsche Telekom; immediately after it on the list was KPN and Sonera (Columbus, 2004, pp. 2-4).

95 Telefónica, *Informe Anual*, 2003, pp. 168 and 254; *Investegate*, December 24, 2003; *El Periódico*, December 24, 2003.

states. This double reality shaped a map with a certain level of diversity and the results varied from one country to another. The evidence provided indicates that the regulatory activity in assigning the scarce resource that was the radio spectrum determined to a large extent the future of mobile telephony, in contrast to the feelings of some contemporary analysts. Furthermore, the strategy of the network operator companies played an important role in the configuration of this varied scene and promised the deployment of the upcoming generations of mobile telephony. Spain presents a case of great interest, in particular due to the late presence of the telecommunications monopoly and for being a country not included among the ten largest telecommunications markets, but with an operating company that was among them, as clearly indicated in the reports from the U.S. International Trade Commission in 2010.

This position and the business performance give us a clear picture of everything that happened with the UMTS. How was it possible that Telefónica anticipated the devaluation of its assets, lowering the business expectations and adjusting its balance, and all of this while facing lower losses than the rest? The simplest response is that by lacking the technological capital developed and accumulated in 3G, Telefónica did not run the risk of losing it, and therefore had not generated any expectations as to its profitability associated with its innovative capacity. Rather Telefónica, with less debt than the other large European operators, stood out for its enormous financial power, explainable by its status as a private monopoly with a significant public holding, sponsored by the government as a cog in the machinery of development and economic intervention and also as an element in the political game as the CEO of the company. When the auctions applied pressure in terms of technology in order to capitalize the market potential over the short term without an adequate technological deployment in place, the most technologically powerful companies and consortia failed. The value of their technological capacity was in fact devalued, but the profitability of Telefónica was not as strongly affected.

8. About the Research

This research is attached to Centre d'Estudis 'Antoni de Capmany' (Universitat de Barcelona, Spain).

9. Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

10. Funding

The author received no financial support for the research, authorship, and/or publication of this article.

11. References

Agar, J. (2013). *Constant Touch: A Global History of the Mobile Phone*. London: Icon Books.

Anttalainen, T. (2003). *Introduction to Telecommunications Network Engineering*. Boston-London: Artech House.

Andersson, P., Hultén, S., & Valiente, P. (2005). Beauty Contest licensing lessons from the 3G process in Sweden. *Telecommunications Policy, 29*(8), 577-593. https://doi.org/10.1016/j.telpol.2005.06.005

Bach, D. (2000). *International Cooperation and the Logic of Networks: Europe and the Global System for Mobile Communications (GSM)*. 12th International Conference of Europeanists, March 30-April 1, 1-38.

Bartolacci, M., & Powell, S. R. (2012). *Research, Practice, and Educational Advancements in Telecommunications and Networking*. Hershey: IGI Global. https://doi.org/10.4018/978-1-4666-0050-8

Bartolini, D. (2005). The Italian Auction for Radio Spectrum Licences. *Quaderni di Ricerca,* 231, 5-31.
Berne, M., & Pogorel, G. (2004). Privatisation Experiences in France. *CESifo DICE Report,* 3(1), 33-40.
Bliksrud, P. (2004). MOU of the GSM-MoU: Memorizing Old Undertakings of the GSM-Memorandum of Understanding. *Telektronikk,* 100 (3).
Börgers, T., & Dustman, C. (2002). Rationalizing the UMTS Spectrum Bids: the Case of the UK Auction. *IfO-Studien,* 48, 77-109.
Börgers, T., & Dustman, C. (2003). Awarding telecom licences: the recent European experience. *Economic Policy,* 18(36), 215-268. https://doi.org/10.1111/1468-0327.00106
Bornheim, S. (2001). *E-Roadmapping: Digital Strategising for the New Economy.* Basingstoke: Palgrave. https://doi.org/10.1057/9780230508446
Cairo, R. (2014). *Co-opetition and Strategic Business Alliances in telecommunications: the cases of BT, Deutsche Telekom and Telefonica de España.* London School of Economics Interdisciplinary Institute of Management, ProQuest LLC.
Calvo, Á. (2016). *Historia de Telefónica: 1976-2000. Las telecomunicaciones en la España democrática.* Barcelona: Ariel/Fundación Telefónica.
Callendar, M. H. (1994). Future Public Land Mobile Telecommunication Systems (FPLMTS). *Third Annual International Conference on Universal Personal Communications,* September 27-October 1, San Diego, California. https://doi.org/10.1109/ICUPC.1994.383096
Calzada, J., & Estruch, A. (2011). Telefonía móvil en España: regulación y resultados. *Cuadernos Económicos de ICE, 81,* 39-69.
Cartelier, L. (2003). Auctions versus beauty contests: the allocation of UMTS licenses in Europe. *Annals of Public and Corporate Economics,* 74 (1), 63-85. https://doi.org/10.1111/1467-8292.00215
Chorafas, D. N. (2006). *Strategic Business Planning for Accountants: Methods, Tools and Case Studies.* Oxford: Elsevier.
Christensen-Dalsgaard, B., Donnelly, W., & Griffith, M. (1999). *Flexible Working: New Network Technologies.* Amsterdam: IOS Press.
Columbus, F. H. (Ed). (2004). *European Economic and Political Issues. Vol 8.* New York: Nova Publishers.
Cowhey, P. F., Aronson, J. D., & Richards, J. E. (2008). The Peculiar Evolution of 3G Networks: Institutional Logic, Politics, and Property Rights. In Drake, W. J. & Wilson E. J. III, (Eds.), *Governing Global Electronic Networks: International Perspectives on Policy and Power.* Cambridge MA: The MIT Press, p. 20. https://doi.org/10.7551/mitpress/9780262042512.003.0093
Cramton, P. (2013). *The Rationale for Spectrum Limits and Their Impact on Auction Outcomes.* GN Docket No. 12-268 & WT Docket No. 12-269, September 9.
Craninckx, J., & Steyaert, M. (1998). *Wireless CMOS Frequency Synthesizer Design.* Dordrecht: Springer. https://doi.org/10.1007/978-1-4757-2870-5
Curien, N. (2002). UMTS in France and Europe: How to allocate the licenses? *Annals of Public and Cooperative Economics,* 73(2), 149-179. https://doi.org/10.1111/1467-8292.00190
Curwen, P. (2002). *The Future of Mobile Communications: Awaiting the Third Generation.* Basingstoke: Palgrave MacMillan. https://doi.org/10.1057/9781403918659
Deloitte, GSMA, & CISCO (2012). *What is the impact of mobile telephony on economic growth?* A report for the GSM Association. Londres: GSMA.
*Didier, M., & Lorenzi, J. H. (*2002). *Enjeux économiques de l'UMTS*. Paris: La Documentation française.
Elias, A., Berenguer, J., & Mataix, J. (2016). El cambio tecnológico, digitalización, satélites, fibra óptica e irrupción de la informática y de las redes de telecomunicaciones. In Calvo, A. *Historia de Telefónica: 1976-2000. Las telecomunicaciones en la España democrática.* Barcelona: Ariel/Fundación Telefónica, pp. 85-156.
ElNashar, A., El-saidny, M., & Sherif, M. (2014). *Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach.* Hoboken NJ: John Wiley & Sons. https://doi.org/10.1002/9781118703434
Ermoliev, Y., & Marti, K. (2012). *Managing Safety of Heterogeneous Systems: Decisions under Uncertainties and Risks.* Dordrecht: Springer. https://doi.org/10.1007/978-3-642-22884-1
Eskelinen**,** H., Vatne, E., Maskell, P., Malmberg, A., & Hannibalsson, I. (2002). *Competitiveness, Localised Learning and Regional Development: Specialization and Prosperity in Small Open Economies.* London-New York: Routledge.
European Commission (1997). *1996 Single Market Review.* Luxemburgo: Office for Official Publications of the European Communities.
Faulhaber, G. R., Madden, G., & Petchey, J. (2012). *Regulation and the Performance of Communication and Information Networks.* Cheltenham: Edward Elgar. https://doi.org/10.4337/9781781007143

Fernández, S., & Mielgo, J. A. (2008). La internacionalización de la empresa española en Europa, la experiencia de telefónica. In Ravina, L., Álvarez, J. L. & Valcaneras, I. (Coords.). *Observatorio sobre el gobierno de la economía internacional.* Madrid: Fundación de Estudios Financieros, pp. 81-90.

Fuentelsaz, L., Maícas, J. P., & Polo, Y. (2008). The evolution of mobile communications in Europe: The transition from the second to the third generation. *Telecommunications Policy, 32,* 436-449. https://doi.org/10.1016/j.telpol.2008.04.008

Girard, J., & Gruber, H. (1996). *Telecommunications network development and investment in the European Union.* Luxemburgo: European Investment Bank.

Glimstedt, H. (2017). *The Dynamics of Innovation in the Wireless Telecom Industry during two Eras of Technological Convergence, 1995-2015.* Working Paper, Stockholm School of Economics, May 9.

Goldsmith, A. (2005). *Wireless Communications.* Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511841224

Gow, G. A., & Smith, R. K. (2006), *Mobile and Wireless Communications: An Introduction.* Berkshire: Open University Press.

Gruber, H. (2005). *The Economics of Mobile Telecommunications.* Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511493256

GSMA (2016). *The Mobile Economy 2016.* London: GSMA.

Halonen, T., Romero, J., & Melero, J. (2004). *GSM, GPRS and EDGE Performance: Evolution Towards 3G/UMTS*. Chichester: John Wiley & Sons.

Heuvelhof, E. F., De Jong, M., Kars, M., & Stout, H. (2009). *Strategic Behaviour in Network Industries: A Multidisciplinary Approach*. Cheltenham: Edward Elgar. https://doi.org/10.4337/9781848449459

Hocepied, C., & Held, A. (2011). The Assignment of Spectrum and the EU State Aid Rules: the case of the 4th 3g license assignment in France. *Competition Policy Newsletter,* 2011(3), 26-30.

ITU (2010). *World Radiocommunication Seminar.* December 6. Geneva: ITU.

ITU (2002). *The evolution to 3G mobile- status report*, on-line.

ITU. (1995). *Public land mobile telephone systems*- Report ITU-R M.742-4, 1978-1995.

Janssen, M. C. W. (2004). *Auctioning Public Assets: Analysis and Alternatives.* Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511610844

Jehiel, P., & Moldovanu, B. (2001). *The European UMTS/IMT-2000 License Auctions.* Working paper. Mannheim: University of Mannheim.

Jelassi, T., & Enders, A. (2005). *Strategies for e-Business: Creating Value Through Electronic and Mobile Commerce. Concepts and Cases.* Harlow: Pearson Education.

Kelen, A. (2001). *The Gratis Economy: Privately Provided Public Goods.* Budapest: Central European University Press.

Ketterling, H.-P. A. (2003). *Introduction to Digital Professional Mobile Radio.* Boston: Artech House.

Khosrowpour, M. (2004). *Encyclopedia of information science and technology*, vol. 5. Hershey PA: Idea Group Reference.

Klemperer, P. (1999). Auction Theory: A Guide to the Literature. *Journal of Economic Surveys,* 13, 227-286. https://doi.org/10.1111/1467-6419.00083

Koskinen, P., & Rouhola, K. (2000). *B-to-B Case: Iobox.* Helsinki: Helsinki University of Technology.

Kruse, J. (2004). Competition in Mobile Communications and the Allocation of Scarce Resources: The Case of UMTS. In Buigues, P. A. & Rey, P. (eds.). *The Economics of Antitrust and Regulation in Telecommunications. Perspectives for the New European Regulatory Framework.* Chentelham: Edward Elgar, pp. 185-212. https://doi.org/10.4337/9781843769767.00024

Lacohée, H., Wakeford, N. †, & Pearson I. (2000). A social history of the mobile telephone with a view of its future. *BT Technology Journal,* 21 (3), 203–211. https://doi.org/10.1023/A:1025187821567

Larsson, S. (2008). *Between Daring and Deliberating - 3G as a sustainability issue in Swedish spatial planning.* Blekinge Institute of Technology.

Lembke, J. (2002). *Competition for Technological Leadership: EU Policy for High Technology.* Chentelham: Edward Elgar.

Lemstra, W., Cave, M., & Bourreau, M. (2017). *Towards the successful deployment of 5G in Europe.* Brussels: Centre on Regulation in Europe.

Lemstra, W., & Melody, W. H. (Eds.) (2014). *The dynamics of broadband markets in Europe. Realizing the 2020 Digital Agenda.* Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139683555

Lescuyer, P. (2012). *UMTS: Origins, Architecture and the Standard.* London: Springer.

Linares, J. (2001). *Primera Conferencia de Inversores.* Río de Janeiro: Telefónica.

Little, Arthur D. (2001). *UMTS: Back to Reality*. Bonn: Eurescom Summit.
Louta, M., Roussaki, I., & Anagnostou, M. (2003). *Implications of 3G licensing to mobile telecommunications market dynamics*. Proceedings of the IEEE International Conference on Telecommunications (ConTEL 2003), vol. 1, June, 113-120. https://doi.org/10.1109/CONTEL.2003.176899
Lurin, P. A. (2010). *Business Planning for Managers: How to Use Powerful Techniques to Write Better Business Plans*. Norderstedt: Investaura.
McKinsey (2002). *Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector*. Final report for the European Commission, June 25.
Medudula, M. K., Sagar, M., & Gandhi, R. P. (2016). *Telecom Management in Emerging Economies: Evolutionary and Contemporary Perspectives*. New Delhi: Springer. https://doi.org/10.1007/978-81-322-2749-6
Mercer, D. (2006). *The Telephone: The Life Story of a Technology*. Westport: Greenwood Publishing Group.
Mock, D. (2005). *The Qualcomm Equation: How a Fledgling Telecom Company Forged a New Path to Big Profits and Market Dominance*. New York: AMACOM.
Muhammad, F. (2008). *An Introduction to Umts Technology: Testing, Specifications and Standard Bodies for Engineers and Managers*. Boca Raton FL: Brown Walker.
Muñoz, X. (2000). Life after UMTS in Spain. *Wireless Networks Online*. April 20.
National Audit Office (2001). *The Auction of Radio Spectrum for the Third Generation of Mobile Telephones, Report by the comptroller and auditor general. HC 233 Session 2001-2002*. London: The Stationery Office.
Navío, J. (2004). Interview with Cayetano Lluch. *Bit, 147,* 24-29.
OECD (2004). *Development of Third-Generation Mobile Services in the OECD*. Paris: OECD.
OECD (2003). *OECD Communications Outlook 2003*. Paris: OECD.
OECD (2002). *Regulatory reform in the telecommunications industry*. Paris: OECD.
OECD (2002ª). *Reviews of Regulatory Reform: Turkey 2002. Crucial Support for Economic Recovery*. Paris: OECD.
OFCOM (2000). *IMT-2000/UMTS mobile radiocommunications licences: decisions on acceptance of applicants and auction rules*. Berna: OFCOM.
Palmberg, C. (2006). *Next Generation Mobile Telecommunications Networks: Challenges to the Nordic ICT Industries*. Bingley: Emerald Group Publishing.
Papadimitriou, G. I., Pomportsis, A. S., Nicopolitidis, P., & Obaidat, M. S. (2003). *Wireless Networks*. London: John Wiley & Sons.
Picot, A., & Doeblin, S. (2013). *Telekommunikation und Kapitalmarkt*. Wiesbaden: Gabler.
Preissl, B., & Müller, J. (2007). *Governance of Communication Networks: Connecting Societies and Markets with IT*. Heidelberg: Physica-Verlag.
Rappaport, T. S., Muhamed, R., Buehrer, R. M., & Doradla, A. (2000). Mobile and Cellular Radio Communications. In Dorf, R. C., *The Engineering Handbook*. Boca Raton: CRC Press.
Rozas, P. (2003*). Gestión pública, regulación e internacionalización de las telecomunicaciones: el caso de Telefónica S.A.* Santiago de Chile: United Nations Publications-CEPAL.
Sánchez, A. M. (2003). *Déficit público, licencias UMTS y Tasa por Reserva del Dominio Público*. X Encuentro de Economía Aplicada, Tenerife, February 2003.
Securities and Exchange Commission (2003). Form 20-F, Commission file number 1-9531, 31 December.
Selian, A. (2001). *3G mobile licensing policy: from GSM to IMT-2000: a comparative analysis*. Geneva: ITU.
Shi, N. (2003). *Wireless Communications and Mobile Commerce*. Hershey: IGI.
Sokol, D. D. (2001).The European Mobile 3G UMTS Process: Lessons From the Spectrum Auctions and Beauty Contests. *Virginia Journal of Law and Technology, 6, Fall* 1-31.
Springer, A., & Weigel, R. (2013). *UMTS: The Physical Layer of the Universal Mobile Telecommunications System*. Berlin: Springer.
Taferner, M. & Bonek, E. (2002). *Wireless Internet Access over GSM and UMTS*. Berlin: Springer. https://doi.org/10.1007/978-3-662-04771-2
Telefónica (2000). *Informe anual*.
Telefónica (2001). *Folleto Reducido de Emisión*. February 22.
Telefónica S.A. (2001). *Informe anual*.
Telefónica. (2002). *Informe Anual*.
Telefónica I+D (2003). *Las telecomunicaciones multimedia*. Madrid: División de Relaciones Corporativas y Comunicación de Telefónica I+D.
Telecommunication Industry Association (2001). *Broadband Spectrum: The Engine for Innovation, Job Growth, and Advancement of Social Priorities*. White Paper, March.

The Council of Economic Advisers (2000). *The economic impact of third-generation wireless technology.* Washington: The Council.
Turner, C. (1997). *Trans-European Telecommunication Networks: The Challenges for Industrial Policy.* London: Routledge. https://doi.org/10.4324/9780203065099
Umar, A. (2004). *Mobile Computing and Wireless Communications.* Philadelphia PA: NGE Solutions.
US International Trade Commission (2010). *Recent Trends in U.S. Services Trade.* Washington: DIANE Publishing.
US International Trade Commission (1993). *Global Competitiveness of U.S. Advanced-Technology Industries: Cellular Communications.* Washington: Information Gatekeepers Inc.
Van Damme, E. (2000). UMTS-auctions in Europe. *Medium Econometrische Toepassingen,* 1, 4-8.
Walke, B. H., Seidenberg, P., & Althoff, M. P. (2003). *UMTS: The Fundamentals.* Hoboken: John Wiley & Sons. https://doi.org/10.1002/0470014148
Whalley, J., & Curwen, P. (2003). Licence acquisition strategy in the European mobile communications industry. *Digital Policy, Regulation and Governance,* 5(6), 45-57.
Zafra, J. M. (2000). Interview: Luis Lada. *El País,* November 8.

12. Origin of the primary sources and documents

Spanish National Stock Market Commission, Madrid.
Archive of the Congress of Deputies, Madrid.
Ministry of Industry and Energy (Ministry of Science and Technology), Madrid.
Telefónica, Books of minutes of the board of administration meetings (LACA), Madrid.
Telefónica, Minutes of the executive committee meetings (ACE), Madrid.